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Donna Creek Winter Furbearer Surveys

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1.0 INTRODUCTION

Alternatives to traditional clearcut harvesting methods are being developed in British Columbia to sustain forest biodiversity. In 1991, the Donna Creek Forestry/Biodiversity Project (DCFBP)was initiated by the Peace/Williston Fish and Wildlife Compensation Program (PWFWCP) to develop and test alternate forest harvesting practices designed to maintain potential critical habitat elements (e.g., wildlife trees, residual green-tree islands) required by wildlife (Dawson *et al* 1992). Though cavity-dependent birds were the main emphasis of this project, winter surveys were also scheduled to assess winter wildlife (furbearers and other small mammals) use of these alternatively logged areas.

The American marten *(Martes americana)* and fisher *(Martes pennanti)* were of particular interest in this study as both martens and fishers have been reported to prefer late-serai forests and avoid open areas (Buskirk and Ruggiero 1994, Powell and Zielinski 1994). These species also use cavities in large diameter trees, snags, and logs typically found in late-successional forests, for resting and denning sites (Buskirk and Ruggiero 1994, Powell and Zielinski 1994). Studies indicate that martens make little use of clearcuts for several decades after harvesting, and populations decline after clearcut logging (Buskirk and Ruggiero 1994). Avoidance of open areas by fishers may restrict their movement between patches of suitable habitat (Powell and Zielinski 1994). Martens are also one of the most economically important species for trappers in the Williston Reservoir watershed (Wildlife Branch, unpubl. data).

This report documents the findings and recommendations arising from the 1993/94 winter furbearer surveys, and documents the methods and results of the more detailed 1995/96 winter furbearer transect and trailing surveys.

2.0 STUDY AREA AND EXPERIMENTAL DESIGN

Donna Creek, at the southern end of the Wolverine Mountain Range, is a tributary of the Manson River which flows east into the Williston Reservoir (Figure 1). The study area is situated along the north side of Solomon Creek, in the Donna Creek watershed. It lies within the moist, very cold variant of the Engelmann Spruce - Subalpine Fir (ESSFmv3) biogeoclimatic zone. Dominant climax tree species include Engelmann spruce *(Picea engelmannii)* and subalpine fir *(Abies lasiocarpa)*, with lodgepole pine *(Pinus contorta* var.

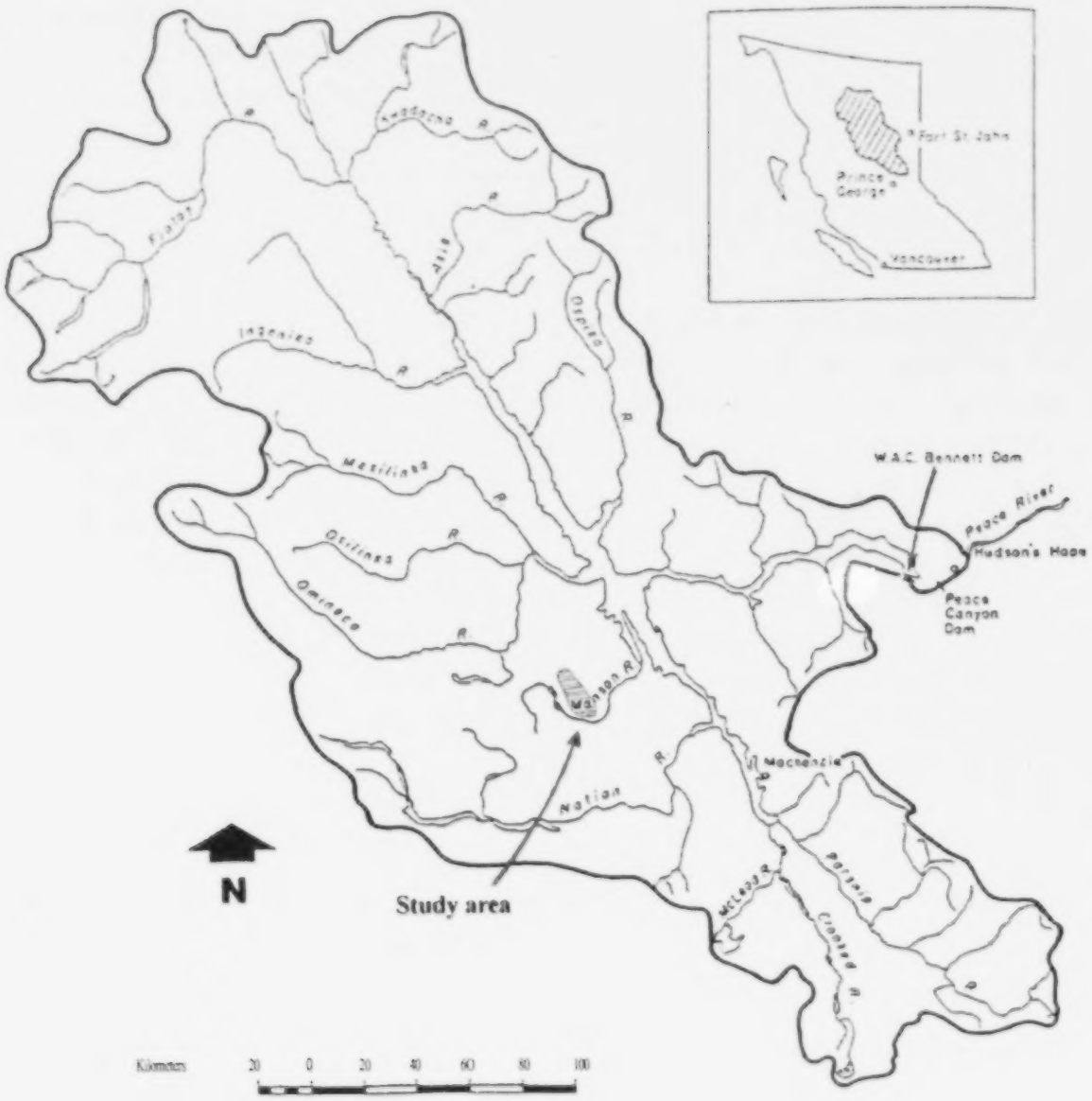

Figure 1. Location of the Donna Creek study area in the Williston Reservoir watershed, north-central British Columbia.

latifolia) as the widespread seral species (Dawson *et al.* 1992). A more detailed study area description is provided in Dawson *et al.* (1992) and Gyug and Summers (1995).

The study area includes six cutblocks, harvested between 1988 and 1992, and three old-growth forest areas (Figure 2). Three of the cutblocks (5516, 5546 and 5547) were subdivided into four treatment areas, while the remaining three cutblocks (5510, 5549 and 5550) were harvested using conventional clearcut methods (i.e., all trees within the cutblock perimeter were cut, resulting in stumps less than 0.5 m in height) (Table 1); cutblocks 5510, 5549, and 5550 were not identified as survey areas until prior to the 1995/96 winter surveys.

Treatment areas within Cutblocks 5516, 5546, and 5547 were differentiated by their harvesting prescription (Appendix A). The Stub treatment (SB) area contains approximately 8 to 10 stubs (tall stumps cut at 3 m in height) per hectare. The Tree-Island treatment (TI) area consists of approximately one residual island of timber (about 0.25 ha in size) for every 8 ha cut. The Stub-and-Island treatment (SI) area has a combination of the two afore-mentioned treatments, and the Clearcut treatment (CT) area has neither stubs nor residual tree islands present (i.e., conventional clearcut).

Table 1. Area and perimeter estimates for treatment and clearcut control cutblocks in the Donna Creek study area.

		Area (ha)[a]					
Block	Harvest year	SB	TI	SI	CT	Total	Perimeter (m)
5510	1988					120.1[b]	5,823
5516	1992	*29.4*	32.1	32.8	25.5	119.8	5,005
5546	1991	23.4	17.6	26.5	23.1	90.6	4,961
5547	1991	18.1	39.3	28.9	26.0	112.3	4,846
5549	1992					74.8[b]	4,347
5550	1992					59.9[a]	4,252

[a] Number of hectares of each treatment per cutblock: Stub treatment (SB), Tree-Island treatment (TI), Stub-and-Island treatment (SI), Clearcut treatment (CT).

[b] Only a 20-25 ha portion of cutblocks 5510, 5549, and 5550 was surveyed.

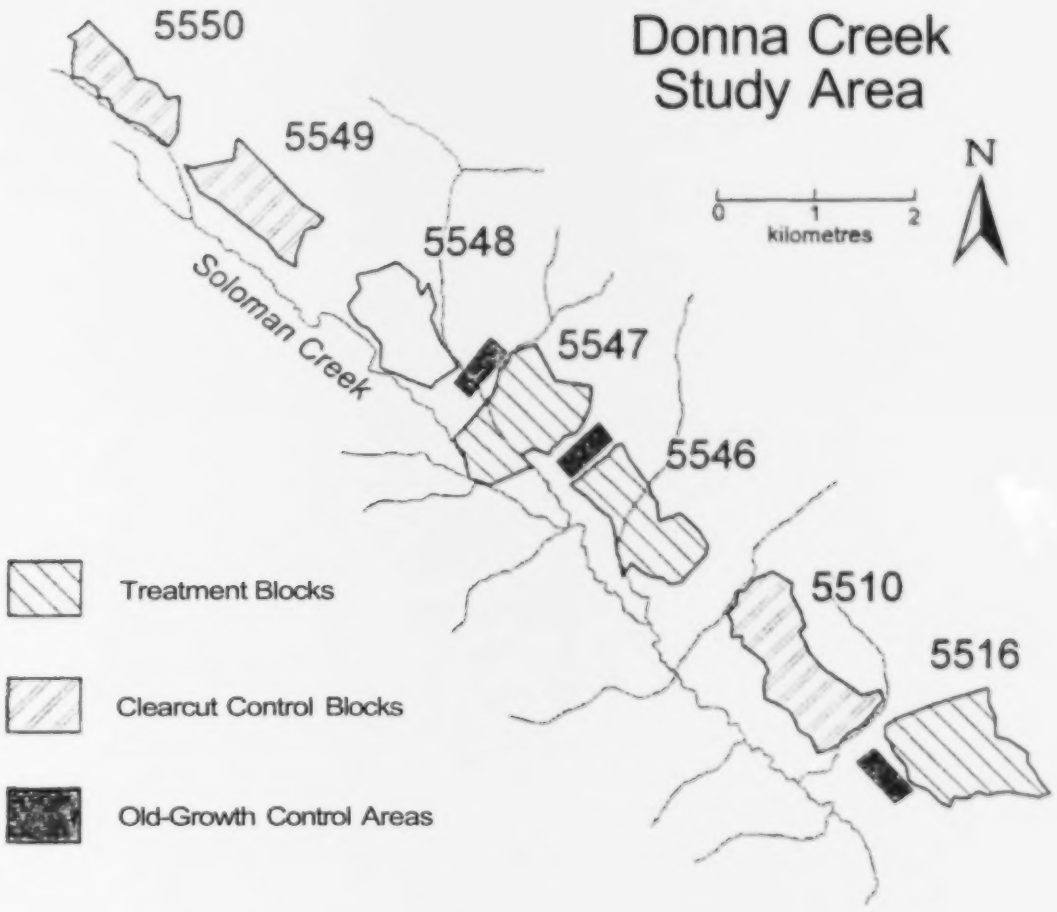

Figure 2. Location of the treatment cutblocks, clearcut control cutblocks, and old-growth control areas in the Donna Creek study area. Figure taken from Gyug, 1996.

Areas identified as controls include the conventional clearcut (CC) cutblocks numbered 5510, 5549, and 5550, and the old-growth forest (OG) areas numbered 1, 2 and 3 (Appendix A). Surveys were only conducted in a 20-25 ha portion of each CC area. Due to planned future timber harvesting in the drainage at the time of project design and to guarantee that the same old-growth areas were available for monitoring in subsequent years, the selection of OG areas was restricted to the forested leave-strips adjacent to the three treatment cutblocks. Each treatment and control area represented an individual sample unit.

3.0 1993/94 SURVEYS

Track transects were scheduled for winter 1993/94 to provide an index of furbearer and other small mammal use of treatment and control areas within the Donna Creek study area. The primary objective was to obtain data on the relative abundance of animals by habitat type (as indicated by the number of tracks per km-day). Secondary objectives were 1) to identify optimal sampling frequency and timing, and determine the time required to conduct a complete survey (e.g., walk all transects once), and 2) to conduct preliminary marten track trailings to determine if trailing was practical, and what was required to conduct more extensive trailing surveys.

3.1 METHODS

3.1.1 Track transects

In 1992, transects were established in Cutblocks 5516, 5546 and 5547, and their associated OG areas (Murray, 1992), for use on spring breeding bird and winter track surveys. Modifications were made to some transects in the spring of 1993 so that all transects within an area (cutblock or forest) were oriented parallel to one another, and traversed the sidehill slope (i.e., roughly maintained the same elevation) (Appendix A). To ensure all portions of a particular area were adequately monitored for use, adjacent transects were separated by about 150 m, resulting in approximately 1.4 km of transect for every 25 ha of area monitored. All transects extended from one edge of the cutblock to the other, thereby bisecting multiple treatments. Transects for the treatment and OG areas averaged 740 m in length (s.d.= 342 m) and ranged from 170 m to 1,390 m.

Each treatment and control area represented a sample unit; for the 1993/94 surveys, 'control' refers to OG areas only. The total length surveyed for an individual sample unit was the sum of all transect segments within each respective treatment or control area. For example, sample unit CT in Cutblock 5546 - 1255 m in length - includes segments of transects "I" (525 m), 'J' (100 m), and 'K' (630 m). It was assumed that the length of transect within a particular area did not influence the likelihood of observing a track. In other words, all segments were of sufficient length to accumulate tracks in the time period allowed. Transect segments for the treatment and OG areas averaged 419 m (s.d.= 179 m) in length, and ranged from 100 m to 800m.

Track observations were converted to frequency of tracks per survey km-day as an index to rank habitat use. Since all transect segments within a specific treatment or control area were not necessarily surveyed within the same time period (i.e., 12 hours), the sample unit's tracks per km-day for a species was calculated by summing the individual segment's tracks per km-day values (derived from dividing the number of tracks observed along the segment by the product of the segment length and the number of days since the last snowfall; cf., Gyug 1988). Non-parametric analysis of tracks per km-day was conducted using the Kruskal-Wallis test (StatSoft, Inc. 1995).

Transects were flagged every 10 m and marked with six-foot metal rods every 50 m. Track locations along a transect were identified by estimating the distance to these markers. Each crossing of a transect by an animal was counted as one track. A 1 m buffer on each side of the transect centre-line was established to reduce the number of crossings for animals such as weasels that normally wander extensively in their movements. If an animal zigzagged along a transect, a new track was counted only if it had exited the buffer area and then returned, again crossing the transect. Where runways (several tracks on top of one another) occurred, an effort was made to count the number of individual tracks present. In the case of snowshoe hares *(Lepus americanus)* and red squirrels *(Tamiasciurus hudsonicus)* this was not always possible, so arbitrary values of four tracks and one track respectively were assigned to each runway (Thompson *et al.* 1989).

PWFWCP staff were to survey all transects, on snowshoes or snowmobiles, once a month from November to March. The transects to be surveyed were divided between two observers, such that each transect was travelled by only one person. When snowmobiling, an average speed of 5-10 km/hr was maintained, with stops to check the identity of tracks and record pertinent information. Tracking was conducted only under ideal survey conditions. Surveys

were carried out in daylight conditions only (i.e., not during dark or dawn and dusk periods), and were not conducted under windy or melting snow conditions. For human safety reasons and anticipated low animal activity, surveys were also not conducted when temperatures were below -30°C. In order to allow tracks to accumulate, at least one full day (24 hours) after a fresh snowfall passed before tracking commenced (Gyug 1993); a 48 to 72 hour delay was preferred. Treatment cutblocks and OG areas were surveyed in random order during each sampling period.

Information recorded on each transect included date, transect name, time of day, days since last snowfall (to nearest half day), amount of snowfall (cm), location of track on transect (±5 m), number of tracks of each species, and direction of tracks (e.g., uphill, across slope, towards residual island). Daily maximum and minimum temperatures were also recorded. Since fisher tracks are hard to distinguish from marten, all tracks were classed as marten unless confirmed otherwise, even though fishers may inhabit the study area. All tracks were recorded as *new* (since the last snowfall), or *old* (during or before the last snowfall). Only *new* tracks were included in calculations and analysis. Sample track transect data forms are given in Appendix B.

3.1.2 Track trailing

Marten track trails followed were sketched onto cutblock maps (scale 1:10,000), indicating direction of travel and important trailing observations (e.g., scent markings, subnivean access points) to potentially identify important habitat features. Each trail was followed by a single observer, using snowshoes.

3.2 RESULTS AND DISCUSSION

3.2.1 Track transects

Insufficient snow coverage until late November and subsequently poor tracking conditions delayed the first survey until late January. Transects in Cutblocks 5516, 5546, and 5547, and their associated OG controls, were surveyed once between 25 and 28 January 1994; a portion of transect 'U' (Cutblock 5516) was not surveyed due to a possible avalanche risk. Logistically it was very difficult for PWFWCP staff to coordinate field activities with other office duties. Therefore, following the January survey, PWFWCP staffing was reduced to one person, and a local trapper was employed to report on weather conditions and assist with subsequent

surveys. Poor snow and weather conditions negated surveys in February and most of March. Finally, Cutblocks 5546 and 5547, OG 1 and OG 2 were surveyed again on 25 March. Cutblock 5516 and OG 3 were not surveyed in March since tracks melted out due to warm temperatures. Transect surveys were divided between the two observers, such that each transect was travelled by only one person.

A total of 107.7 km-days was surveyed during January and March, with 137 red squirrel, 115 weasel (*Mustela spp),* 73 snowshoe hare, 61 marten, 18 wolf *(Canis lupus),* 4 coyote *(Canis latrans),* 3 lynx *(Lynx canadensis), 2* vole/mouse, and 1 fox *(Vulpes vulpes)* tracks counted (Appendix C). All squirrel tracks and all but four snowshoe hare tracks (all from the same individual) were recorded in the OG controls.

The majority (90%) of marten tracks were observed in January (Table 2). No tracks were found within Cutblock 5516 treatment areas, while Cutblock 5547 had marten tracks in all treatments; however, only one track was observed in the CT treatment. Most tracks in Cutblock 5547 were distributed throughout the SB, TI and SI treatments; there were no apparent areas of concentrated marten activity. Marten tracks in Cutblock 5546 were only found distributed across the western half of the cutblock (SB and SI treatments) and evidence of inter-island movements was noted. During the March survey (which was limited to OG1 and OG2, and Cutblocks 5546 and 5547), marten tracks were found only in the OG areas.

Thompson *et al.* (1989) also reported fewer marten track counts in March than in January, and suggested that this may represent a decline in the local population due to over-winter mortality factors and trapper harvest. No marten or fisher were known to be harvested from the Donna Creek study area between the two survey periods (J. Besherse, trapper, pers. comm.). Though natural winter mortality may have played a part in the reduced number of marten tracks observed, other factors, such as use of alternate habitats (i.e., outside the survey area) and animal dispersal, are more likely the source of this decline.

OG areas had the highest indices of marten use during both survey periods: 2.34 tracks/km-day in January and 0.52 tracks/km-day in March (Table 3). However, there was no significant difference in the number of marten tracks per km-day among the OG, CT, SB, SI, and TI areas in either month (Kruskal-Wallis; H_{Jan}=3.46, p=0.45, N=15; H_{Mar}=8.89, p=0.06, N=10).

Weasel tracks were also more prevalent in January than March (Table 2). In January, weasel tracks were widespread throughout Cutblock 5516, and also in the TI treatment of Cutblock

Table 2. Number of marten and weasel tracks observed in each sample unit of the Donna Creek study area during January and March 1994 survey.

		Marten			Weasel		
Area[1]	Block	January	March	Total	January	March	Total
OG	OG3	3		3	6		6
	OG2	11	2	13	1	1	2
	OG1	6	4	10	0	8	8
	Total	20	6	27	7	9	16
CT	5516	0		0	25		25
	5546	0	0	0	0	0	0
	5547	1	0	1	0	1	1
	Total	1	0	1	25	1	26
SB	5516	0		0	17		17
	5546	0	0	0	1	0	1
	5547	13	0	13	0	18	18
	Total	13	0	13	18	18	36
TI	5516	0		0	13		13
	5546	8	0	8	0	0	0
	5547	7	0	7	10	0	10
	Total	15	0	15	23	0	23
SI	5516	0		0	14		14
	5546	2	0	2	0	0	0
	5547	4	0	4	0	0	0
	Total	6	0	6	14	0	14
	TOTAL	55	6	61	87	28	115

[1] Area abbreviations: OG (old-growth control), CT (Clearcut treatment), SB (Stub treatment), TI (Tree-Island treatment), SI (Stub-and-Island treatment).

Table 3. Number of marten and weasel tracks per km-day observed per treatment and control type in the Donna Creek study area during January and March 1994.

	n[2]	Total km-days	Marten tracks/km-day X ± SD		Weasel tracks/km-day X ± SD	
Area[1]	J/M[3]	J/M	January	March	January	March
OG	3/2	11.2/11.3	2.34 ± 1.60	0.52 ± 0.20	0.43 ± 0.51	0.75 ± 0.79
CT	3/2	9.7/ 5.6	0.17 ± 0.30	0	2.07 ± 3.59	0.84 ± 1.18
SB	3/2	10.9/14.8	0.95 ± 1.64	0	1.57 ± 2.36	0.89 ± 1.26
TI	3/2	11.6/13.3	1.87 ± 1.90	0	2.63 ± 2.72	0
SI	3/2	7.1/ 8.3	1.58 ± 1.92	0	1.14 ± 1.98	0

[1] OG (Old-growth control), CT (Clearcut treatment), SB (Stub treatment), TI (Tree-Island treatment), SI (Stub-and-Island treatment).

[2] n= number of sample units per treatment or control type, per survey period.

[3] Survey period: J - January, M - March.

5547. For January and March, only a single set of weasel tracks was observed in Cutblock 5546 (SB treatment). Tracks were observed in each of the OG areas, except for OG1 in January. For each month, there was no significant difference in the number of weasel tracks per km-day between OG, CT, SB, SI and TI areas (Kruskal-Wallis; H_{Jan}=0.93, p=0.92, N=15; $H_{Mar.}$=3.91, p=0.42, N=10). The high number of tracks per km-day for weasels in some areas resulted from individual animals excessively zigzagging along one or two transects, and usually this was along a short section of a transect.

The 18 wolf tracks that were observed resulted from a pack of three wolves crossing six transects as they passed through Cutblock 5547 from top to bottom in March. Similarly, the coyote observations involved a single coyote traversing the southern portion of Cutblock 5546. Although not found along the surveyed route, one set of wolverine tracks was observed in the OG 3 area in March. The greater presence of larger carnivores (wolf, coyote, fox) in March was likely due to a firm crust being present under the recent snowfall, thereby providing easier movement conditions. This firm layer also enabled observers to travel treatment cutblock transects using snowmobiles. Conducting track surveys after snowmobiles were used (particularly in softer snow conditions) may impart a potential bias, as it could create compacted travel routes for wildlife.

Incidental observations of winter bird activity in the treatment cutblocks during the track transect surveys were restricted to the tree-islands of the SI treatment; one hairy woodpecker *(Picoides villosus;* Cutblock 5547) and a set of grouse tracks (Cutblock 5546) were noted. In OG controls, observations included four black-capped chickadees *(Parus atricapillus),* two black-backed woodpeckers *(Picoides arcticus),* two gray jays *(Perisoreus canadensis)* and a red-breasted nuthatch *(Sitta canadensis).*

3.2.2 Track trailing

All marten tracks in the SI treatment of Cutblock 5546 were trailed on 20 January 1994. Tracks were trailed from the cutblock perimeter to the point they exited the SI area. Four marten tracks were trailed for a total of approximately 1,500 m. All tracks entered at least one residual tree-island, and four subnivean access points were observed; three subnivean sites were observed within residual islands and one in the stubs portion of the SI treatment (Appendix D). A urine scent mark was noted along one of the trails in the stubs portion of the SI treatment. Stubs appeared to have no influence on marten movements as trailed animals did not visit any. Movements made from the forest edge to a tree-island, and between tree-islands, appeared to be relatively direct (e.g., straight line), while within-island movements were somewhat meandering. The latter, however, may simply be due to more

obstacles (e.g., trees, downed logs) within the residual tree-islands rather than the animal showing signs of differential movement patterns.

3.3 RECOMMENDATIONS FOR SUBSEQUENT SURVEYS

3.3.1 Study design

- Transects should be established in cutblocks that were conventionally logged in their entirety (i.e., clearcut controls - no stubs or residual tree islands) to address possible adjacency effects of other treatments on CT areas within the treatment cutblocks.
- Trailing surveys for martens and fishers should be conducted in all treatment and control areas to assess differences in movement and behaviour patterns, and to identify other potentially important habitat features present (e.g., debris piles, creeks, regenerating conifer patches).

3.3.2 *Sampling design*

- A minimum of two complete transect and trailing surveys should be conducted monthly from December to January, when relative marten densities appear to be greatest (this study; Thompson *et al.* 1989).
- Surveys should be conducted in at least two consecutive winters to account for potential annual fluctuations in animal habitat use.
- Only sample units with a minimum of 20 km-days per survey period (i.e., per month) should be used for analysis purposes (Gyug 1988).

3.3.3 Survey methods

- A hip chain and compass should be used to identify the location of tracks encountered on all transect surveys.
- Track trails should be sketched on detailed maps or airphotos which accurately (i.e., ± 5 m) illustrate cutblock characteristics, so that animal movements in treatment and clearcut control cutblocks may be graphically presented.
- Survey work should be contracted out; contractors should be stationed at Munro Camp to make better use of favourable tracking conditions.
- The snowmobile route to the study area should be maintained (e.g., travelled) after every heavy snowfall, even when no surveys are being conducted, to alleviate accessibility problems.

- Surveys should be conducted using snowshoes, instead of snowmobiles, to reduce the chance of providing compacted travel routes which may possibly influence animal movement patterns.

4.0 1995/96 SURVEYS

Because insufficient data was collected in 1993/94, further track transect surveys were warranted and, based on the recommendations arising from the 1993/94 work, the sampling and study designs were modified. Winter 1995/96 was scheduled to be the first of two consecutive years of winter track surveys to assess furbearer use of alternatively logged areas. Conventionally clearcut (CC) areas were added as a control to contrast treatment cutblocks, therefore four treatment and two control types were to be surveyed during winter 1995/96. In addition to the transect surveys, more intensive marten and fisher track trailing was proposed to provide information about their movement patterns in the various habitat types present in the study area. The aim was to complete a minimum of two surveys of all treatment and control areas during each monthly sampling period (December and January). All survey work was conducted by contractors.

4.1 METHODS

4.1.1 Track transects

In the winter of 1995/96, the same treatment cutblocks and OG areas were surveyed as in 1993/94, with the addition of transects in the 20-25 ha portions of CC Cutblocks 5510, 5549 and 5550. The CC transects were established in the same manner as were the transects in the treatment and OG areas. CC transects ranged in length from 585 m to 775 m (Appendix A), resulting in an overall average transect length of 744 m (s.d.= 314 m; range 170 - 1,390 m) for the study area; overall segment length therefore averaged 442 m (s.d.= 184 m; range 100 - 800 m). Transects were traversed by one individual on snowshoes, using a compass and hip chain. The 1 m buffer on each side of the transect centre-line was extended to 2 m for weasel tracks only.

4.1.2 Track trailing

For each trailing survey, all treatment and control area perimeters were walked. Perimeter boundaries for the OG areas were defined by using the upper and lower transects present in the particular OG area. The cutblock perimeter and innermost transect were used to define the CC areas. The survey areas were divided between two observers, such that track trails encountered were followed by one

person only. Tracks encountered were back-tracked (i.e., tracked in reverse with respect to the animal's direction of travel) to negate potential observer influence on the animal's movement and behaviour; forward trailing was only conducted when back-trailing was not possible. Tracks observed in the treatment and clearcut control areas were trailed for their entirety (i.e., until they left the cutblock). For old-growth areas, tracks were followed until either the animal exited the old-growth forest, a distance of 500m had been trailed, or two hours had elapsed since trailing commenced. Because trailing was identified as a lower priority than transect surveys, a complete transect survey was attempted before any track trailing was undertaken.

A maximum of four tracks per area were to be trailed each survey; if more than four tracks per area existed then four were selected at random. An attempt was made to walk all treatment and control perimeters prior to commencing the next survey. As with the transect surveys, all marten and fisher tracks were classed as marten unless track identity was confirmed as fisher (e.g., larger track prints, propensity to walk rather than 2x jump). Trailing was initiated as long as snow and weather conditions were suitable for tracking; no 24 hour delay after the last snowfall was required.

Information for individual trails was recorded on track trailing forms (Appendix B) and, for treatment and CC areas, a rough sketch of each trail was also made on laminated cutblock photographs (colour 35 mm photographs were laser-copier enlarged to a scale of approximately 1:8,400). Data collected included observation date, time of day, start location, track number, and species trailed. Compass and hipchain were used to measure bearings and distances travelled by the observer while trailing. The animal's stride (e.g., 2x2 jump, 1x2x1 lope), and apparent movement/behaviour (e.g. straight-line, zigzag) were noted, as well as the locations of subnivean access points and resting sites. The trailing information and rough sketch-maps were later compiled and mapped at a scale of 1:2,500 to better illustrate animal movements within and among treatment areas (Appendix E).

In an attempt to compare movement patterns in the different habitat types, the ratio of total distance travelled by an animal to actual (direct) distance travelled was calculated. A value of '1' describes a straight-line route from point A to B, values greater than one reflect a more meandering path, possibly suggestive of foraging behaviour. This 'linearity index' was used as a potential indicator of differences in movement patterns among three habitat types: old-growth, tree-island, and non-treed. Linearity ratios were calculated for each trail segment that occurred in a different habitat type. Non-treed areas were cut areas with or without stubs within the treatment cutblocks. If an animal, for example, travelled through an area with stubs into a tree island and then across a clearcut area, three ratios would be calculated: 1 for tree-island and 2 for non-treed. ANOVA (α=0.05; StatSoft, Inc. 1995) was

used to determine if there was any significant difference among pooled marten and fisher trail linearity indices for the three habitat types.

4.2 RESULTS AND DISCUSSION

4.2.1 Track transects

Three survey periods were attempted from early December to early January but only a few transects were completed satisfactorily; transects 3A and 3B (OG 3) were surveyed on 13 December 1995 and transects 'R', 'S', 'T', 'U' (Cutblock 5516) were surveyed on 4 January 1996. Seven squirrel tracks were observed in the OG, four weasel tracks were encountered along transect 'R' (2 in the SI treatment, 2 in the CT), and the body and wing prints of an owl were noted along transect 'S'. No marten or fisher tracks were observed. Wind and frequent snowfalls prevented data collection for the other transects during these sampling periods. On several occasions, trips were made to the study area but conditions were not suitable for tracking. No tracks per km-day indices were calculated for these surveys as minimal tracking data was collected.

Due to the lack of suitable tracking conditions for transect surveys, the emphasis was switched to track trailing after the first week of January.

4.2.2 Track trailing

Although the survey emphasis was switched to trailing in early January, melting snow, ice crusts, and a lack of fresh snowfall further delayed surveys until the end of the month. Trailing efforts were therefore extended into February.

Seventeen perimeter surveys to locate tracks for trailing were conducted from 25 January to 28 February: once for Cutblock 5546, and twice for OG areas and Cutblocks 5510, 5516, 5547, 5549, and 5550. A total of 31 separate sets of marten and fisher tracks were encountered on the perimeter searches: 5 in treatment areas and 26 in OG areas (Appendix E). On the perimeter walks, weasel and snowshoe hare tracks were observed regularly, and red squirrel, ptarmigan, wolverine and mouse tracks were also noted. On 27 February, observers noted the presence of wolf tracks spanning the width of Cutblock 5549, indicating that a group of 5-6 individuals had recently travelled through the block.

The 5 sets of *Martes* tracks that were followed within treatment areas included 2 marten and 1 fisher in Cutblock 5547, 1 fisher in Cutblock 5546, and 1 marten in Cutblock 5516. Both fishers and two of the three martens either entered or came to the edge of at least one residual island. The remaining marten closely followed the creek in Cutblock 5547 from the forested edge through the SB treatment, entering and exiting shrub and downed log areas along the way. Its tracks were lost near the SB/CT boundary so whether or not it followed the creek into the CT area cannot be confirmed. There were actually two marten trailings done in Cutblock 5516 (see JP1 & JP2, Appendix E), however these were considered to be tracks from the same individual as it appeared that the marten ventured out (67 m) from the largest tree island (Island 16-2), then returned to it, and later emerged from the island again to meander through a second tree island before entering the forest. Since the tracks initiated from the island, this may indicate that the animal denned or rested somewhere in the island.

The marten leaving the SI treatment of Cutblock 5547 urinated and dug in the snow just prior to entering the old-growth forest. The fisher in Cutblock 5547 took an erratic route through the SI treatment, travelling to the edge of two residual tree islands, passing through a third, and possibly entering a fourth. The tracks were obscured prior to reaching the fourth island but tracks of similar size, and heading in the anticipated direction, were observed in the island. No marten or fisher tracks were observed in any of the CT or CC areas.

A total of 26 separate sets of marten and fisher tracks were followed in the old-growth areas: 8 martens in OG1, 7 martens and 1 fisher in OG2, and 12 martens in OG3 (Appendix E). Thirteen urination sites were noted along ten of the marten trails, including two along a single trail in OG3 and three on another in OG2. At two sites, urination was accompanied by digging into the snow. Subnivean access sites were recorded in all OG areas: 2 in OG1, 5 in OG2, and 3 in OG3. Three sets of trailed marten tracks, one in OG1 and two in OG3, were described as 'stopping frequently' at holes, debris, and other animal tracks. Four marten trails (3 in OG2 and 1 in OG3) followed snowshoe hare runs. Based on the above information, it appears that foraging (i.e., accessing subnivean sites) and scent marking behaviours are more prevalent in the OG areas than in the treatment areas.

Linearity ratios were calculated for all track trails except for one marten trail in Cutblock 5547 (Table 4, Appendix F). Since this marten followed a creek for its entirety, its path was thought to be solely influenced by the creek and not by treatment features, and therefore was not included in the analysis. Two linearity ratios were calculated for trail JP 1 (one describing its path away from the island and another describing its return to the island).

Table 4. Summary of calculated linearity indices.

Habitattype	n[a]	X ± SD
Non-treed	8	1.16±0.14
Tree-island	4	1.56 + 0.81
Old-growth	26	1.99 ± 1.70

[a] n= the number of trails, or portions thereof, in each habitat type.

At a 0.05 level of significance, linearity indices of pooled marten and fisher trails do not differ significantly among habitat types (F=1.06; 2,35 df; P=0.36). If such ratios are to be useful, however, some refinements to the data analysis may need to occur. For example, calculations may need to be derived from intervals along travel paths to more accurately reflect meandering/foraging and travel intervals. Note that this may be limited by study design, as setting an arbitrary minimum (direct) distance interval of >100 m travelled per habitat type would exclude all the tree islands in this study (except the large island in 5547), as the diameter of these islands are less than 75m.

5.0 SUMMARY (1993/94 AND 1995/96)

For both survey years (1993/94 and 1995/96), using either sampling technique, no marten or fisher tracks were observed in any of the CC areas, and only one set of marten tracks was ever noted within a CT treatment. In 1994, tracks (i.e., tracks per km-day) were most prevalent in OG areas but no significant difference was found between OG and treatment areas. The distribution of tracks observed along transects did not indicate that there were any areas of concentrated marten or fisher use. In 1995/96, very limited track transect surveying was conducted and no marten or fisher tracks were observed. From trailing surveys in 1996, four of the five track trail sequences which entered a treatment area visited at least one residual island. The exception involved a marten following and criss-crossing a creek for the trail's entire monitored length. The lack of tracks observed in CT and CC areas, and the fact that essentially all the animals using the treatment areas frequented a timbered island, suggests that the timbered islands are influencing the animals' movement patterns. However, at this point it is unclear if timbered islands and/or stubs provide any benefit to martens or fishers during the winter, as use of the treatment areas does not inherently imply that the presence of the particular habitat features is beneficial to the individual or species.

6.0 RECOMMENDATIONS

A. The DCFBP study area and design, being primarily contrived for cavity-dependent bird surveys, is not appropriate to meet the original objectives of the project's winter furbearer component. Further work at this site to address marten and fisher habitat use questions at scales equal to or greater than stand-level (i.e., treatment area or cutblock) is not recommended.

- Individual marten home ranges average 1-4 km^2, and can be significantly larger in clearcut areas relative to the size of those in uncut areas (Buskirk and Ruggiero 1994). Fisher home ranges are generally greater than 15 km^2 (Powell and Zielinski 1994). Since both are solitary, territorial animals, and all treatment cutblocks are within approximately a 56 km^2 area, it is unlikely that many individuals are present within the study area. Cutblocks were also linearly arranged, and similar cutblocks (e.g., treatment [5546 and 5547], control [5549 and 5550]) were in close proximity to one another, therefore there was little interspersion among like habitats. For these reasons, the data available to be collected is likely only from a few animals and thus not very indicative of general marten and fisher use of harvested areas in ESSFmv3 habitats, or even for the Donna Creek watershed

B. The DCFBP could be redesigned to address smaller scale spatial (i.e., patch and element level) questions with respect to winter habitat use by furbearers (marten and fisher).

- Track trailing surveys have limited quantitative value with respect to animal numbers, but they do have qualitative value in terms of assessing furbearer behaviour and movement patterns. To assist with habitat use analyses, the presence of potentially important habitat features (e.g., snags, creeks, debris piles, sapling conifer trees, deciduous trees) which may influence the usage of an area by furbearers should be documented (i.e., mapped). This will aid in determining if treatment attributes (snags, islands) or other habitat features are the influencing factor(s) affecting the use of an area. These habitat features have been shown to influence fisher and marten movements (Buskirk and Ruggiero 1994; Powell and Zielinski 1994).
- It is very difficult to plot track trailing data in the office without a visual reference of at least the recorder's starting point, therefore all track trailings conducted should at least be sketched in the field on detailed cutblock maps. Since calculations are based on mapping accuracy, consistent recording of data is crucial. Alternatively, using portable Global Positioning Systems (GPS) units to record track trailing work would help alleviate problems with mapping and standardize the data obtained by various observers. This technology can be used

in combination with Geographic Information System (GIS) software to record noteworthy sites (e.g., kill sites, subnivean access sites, habitat features) in the field, and subsequently aid plotting of the animal's actual path within the microhabitat or landscape and analysing the data in relation to GIS layers of habitat features (Arnett *et al.* 1995).

- Island size, the distance between islands, and the distance from islands to old-growth forest should be considered in the evaluation of furbearer movements within the treatment cutblocks since these distances may influence fisher and marten movements.
- Since non-parametric analysis has an inherent shortfall of hiding effect size (i.e., using ranks rather than measured values), analysis of future tracking work conducted over multiple surveys should use other analytical methods (e.g., histograms, mean-variance graphs) to look at possible effect differences.
- Though track trailing can provide a valuable insight into animal use of the study area, differential patterns of use are difficult to interpret analytically without a sufficient number of tracks. The ability to conduct winter track trailing surveys is weather dependent, and suitable tracking conditions appear to be relatively rare and unpredictable for the Donna Creek study area. It is therefore important to dedicate sufficient effort to ensuring that adequate data is collected for meaning statistical analysis; conducting a power analysis prior to initiating any surveys will assist in identifying what level of effort will potentially be required.

C. For the winter furbearer component of the DCFBP, it may be more useful to look at prey densities and other species associations as indicators of habitat suitability.

- Habitat use by marten has been shown to vary as a function of prey abundance (Buskirk and Ruggiero 1994). A fisher's use of an area may also change with changing prey density, and high prey density may be an important determinant for fisher home range sites (Powell and Zielinski 1994). Squirrel middens are important resting sites for martens (Buskirk and Ruggiero 1994) and snowshoe hares are primary fisher prey (Weir 1995). Both squirrel and hare tracks were repeatedly observed in the study area. An assessment of available prey, in addition to an evaluation of preferred or essential habitat features, may provide a more comprehensive analysis with respect to habitat availability for martens and fishers.

7.0 REFERENCES

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8.0 APPENDICES

Appendix A: Maps of cutblocks and old-growth areas showing transect layout.

Cutblock 5510

Cutblock 5516 and OG 3

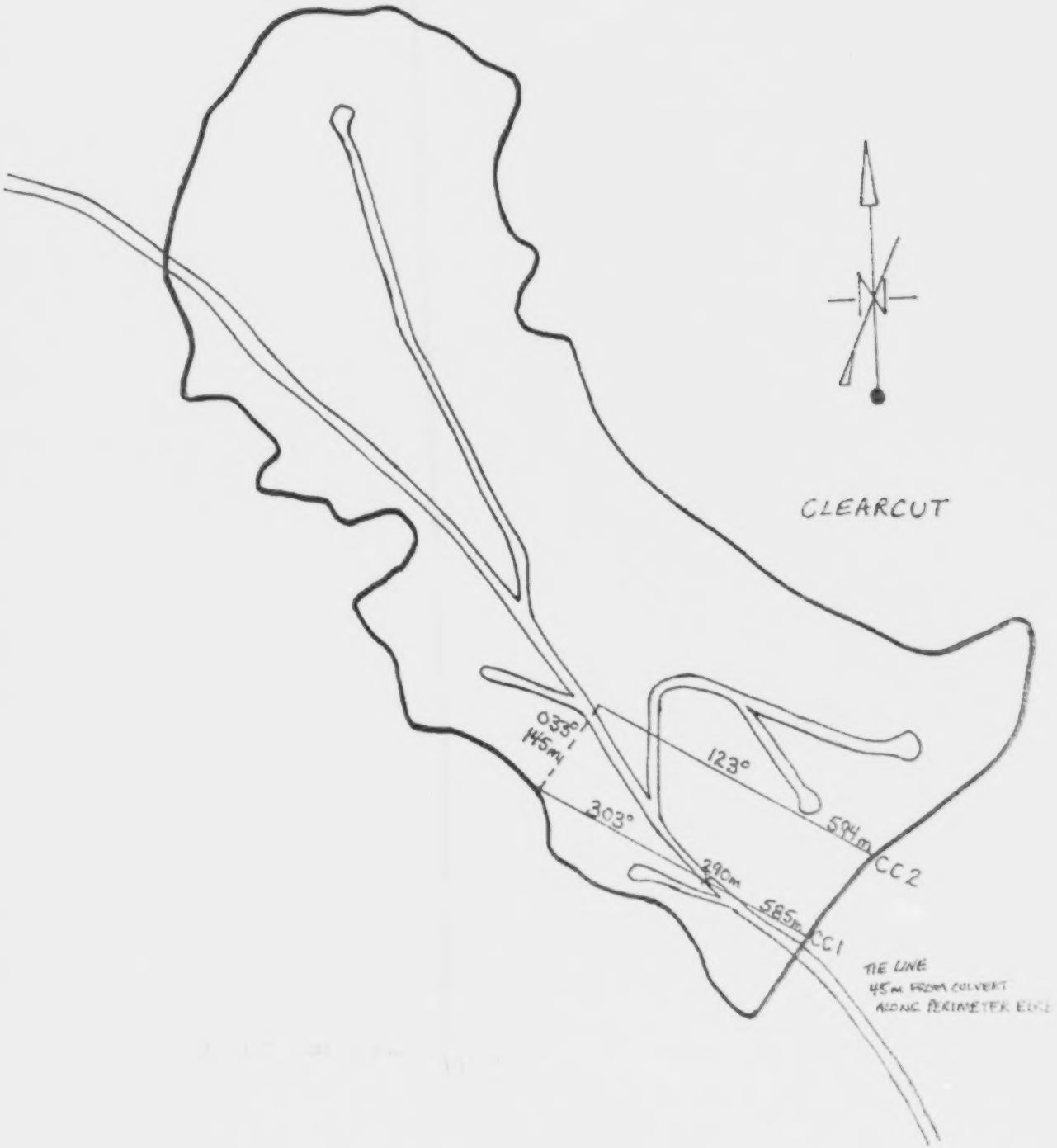
Cutblock 5546 and OG 2

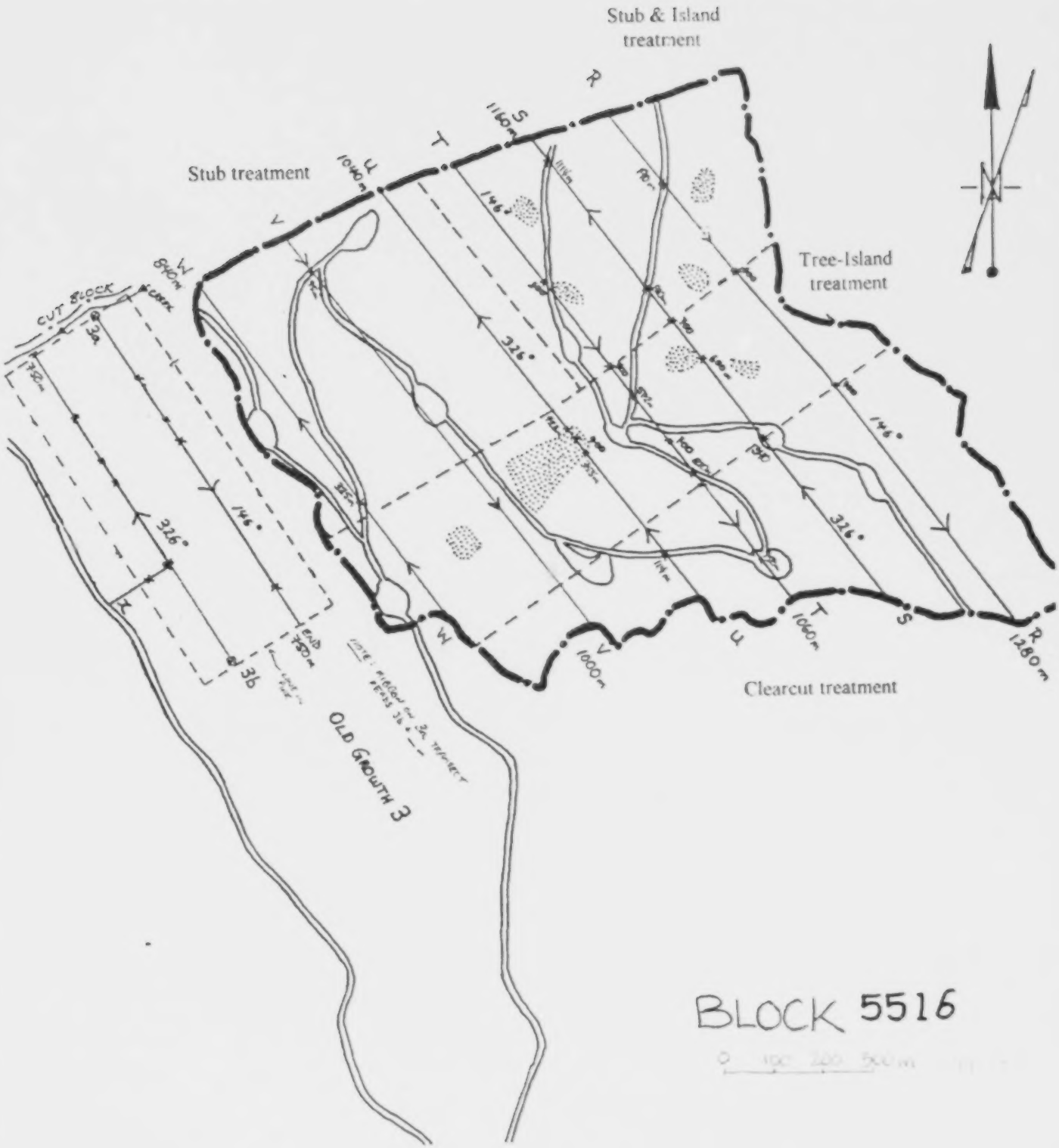
Cutblock 5547 and OG 1

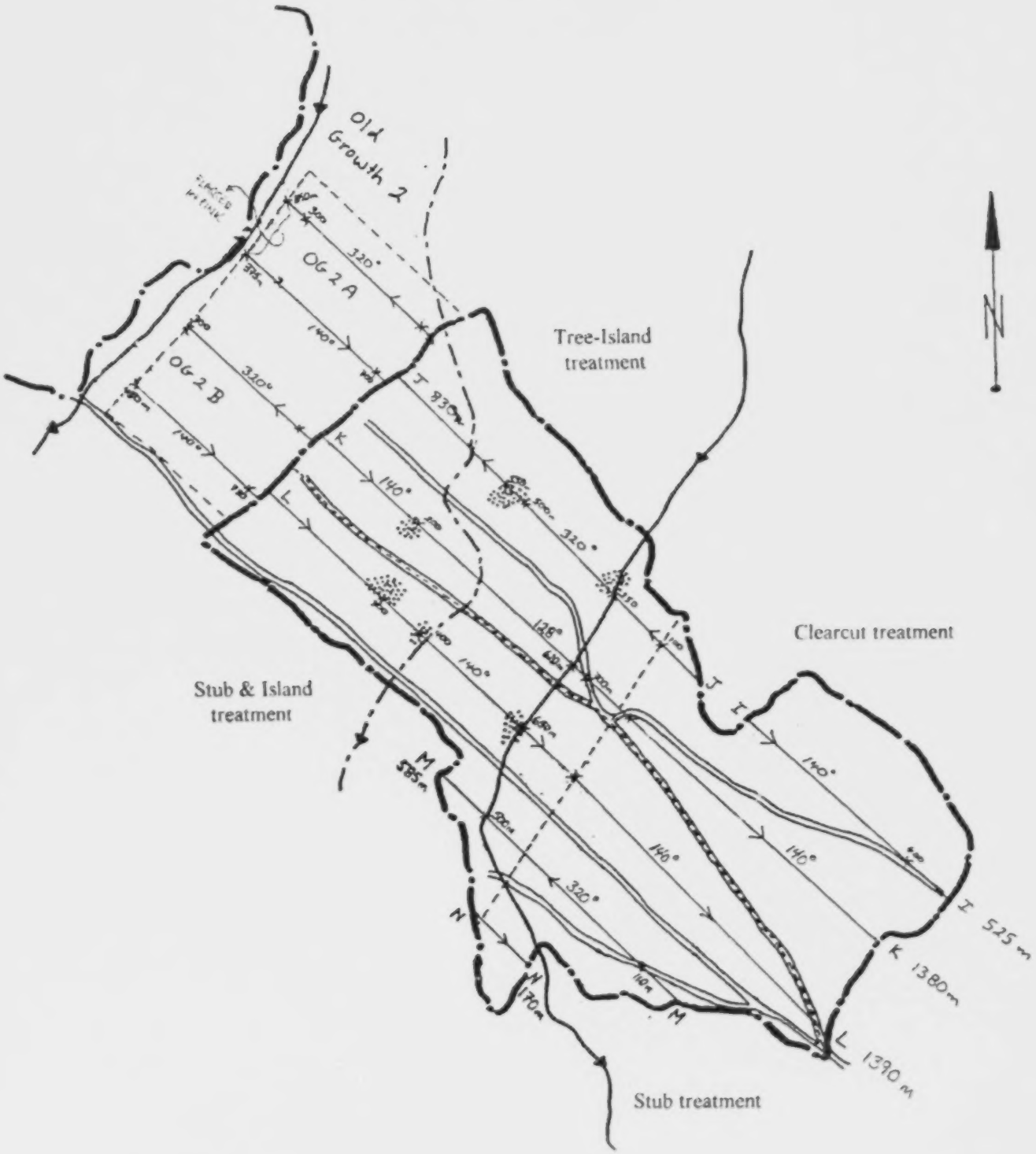
Cutblock 5549

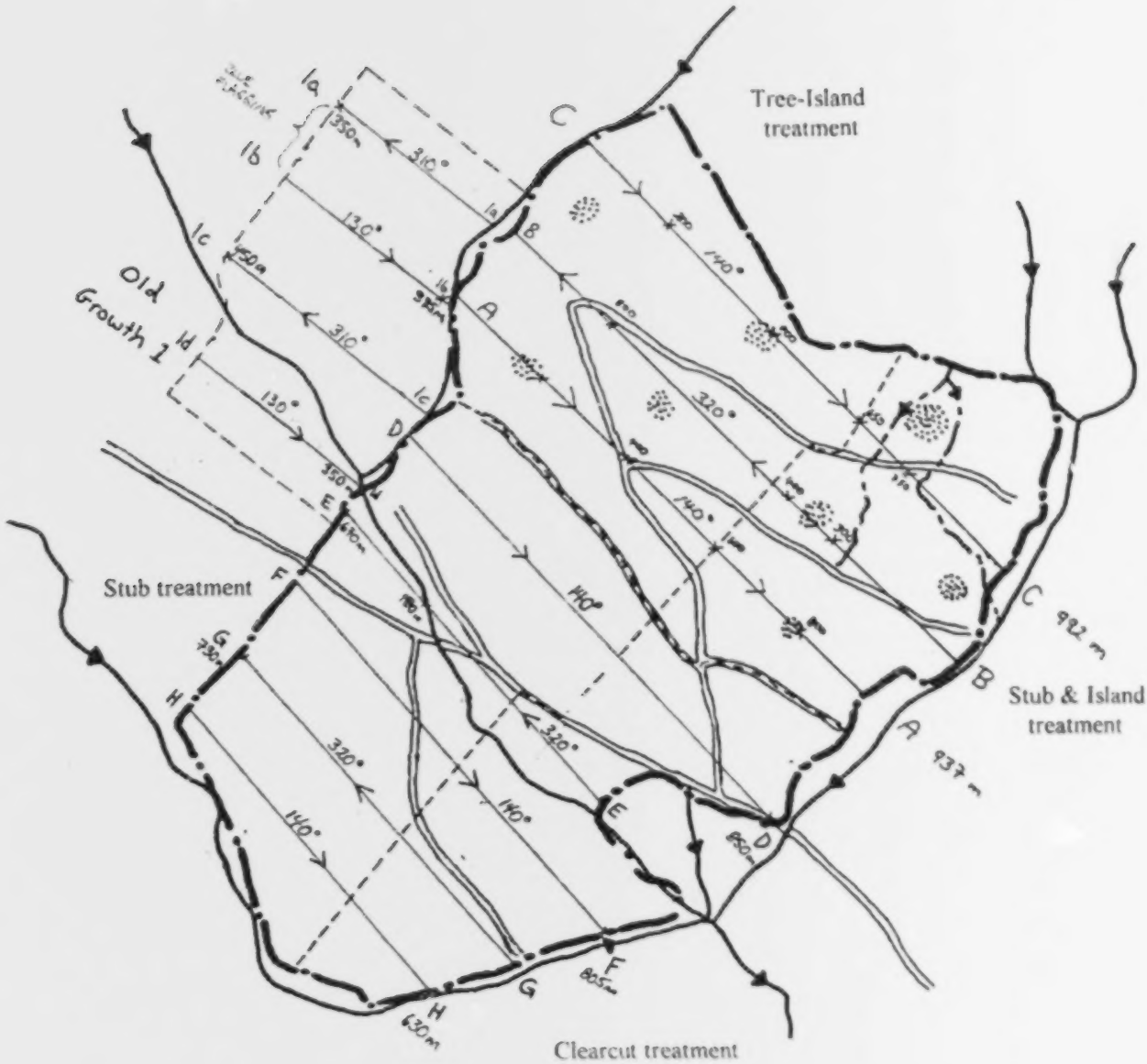
Cutblock 5550

BLOCK 5510

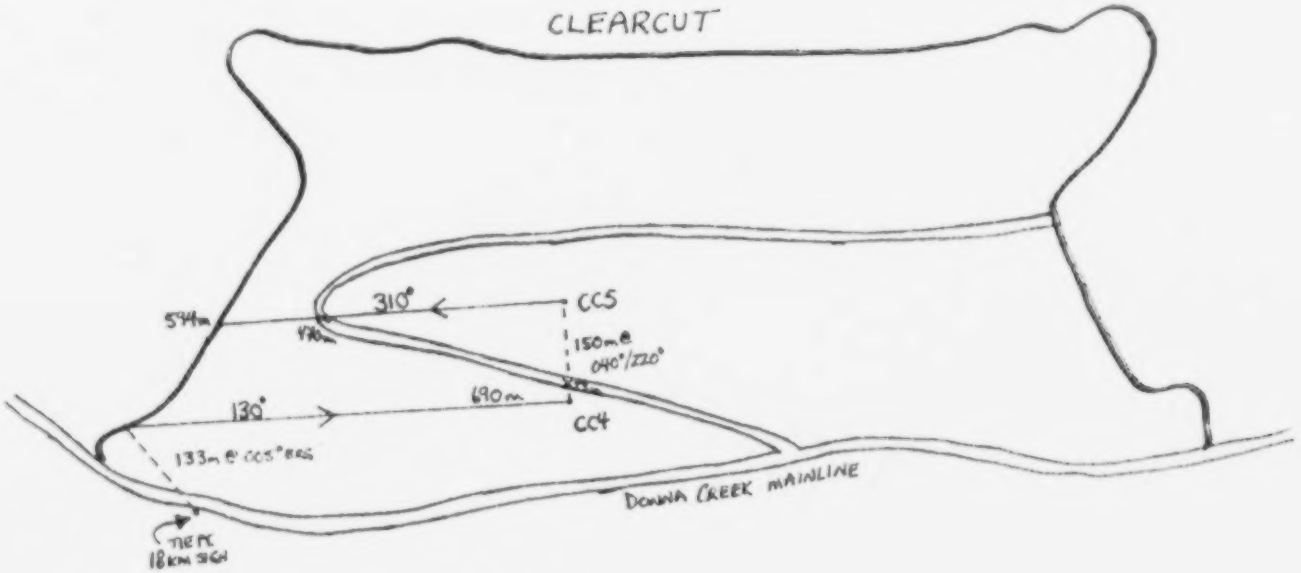

CLEARCUT
033°
145m
123°
303°
594m
CC2
290m
585m
CC1
TIE LINE
45m FROM CULVERT
ALONG PERIMETER EDGE


Stub & Island
treatment
Stub treatment
Tree-Island
treatment
Clearcut treatment
CUT BLOCK
OLD GROWTH 3
326°
146°
BLOCK 5516

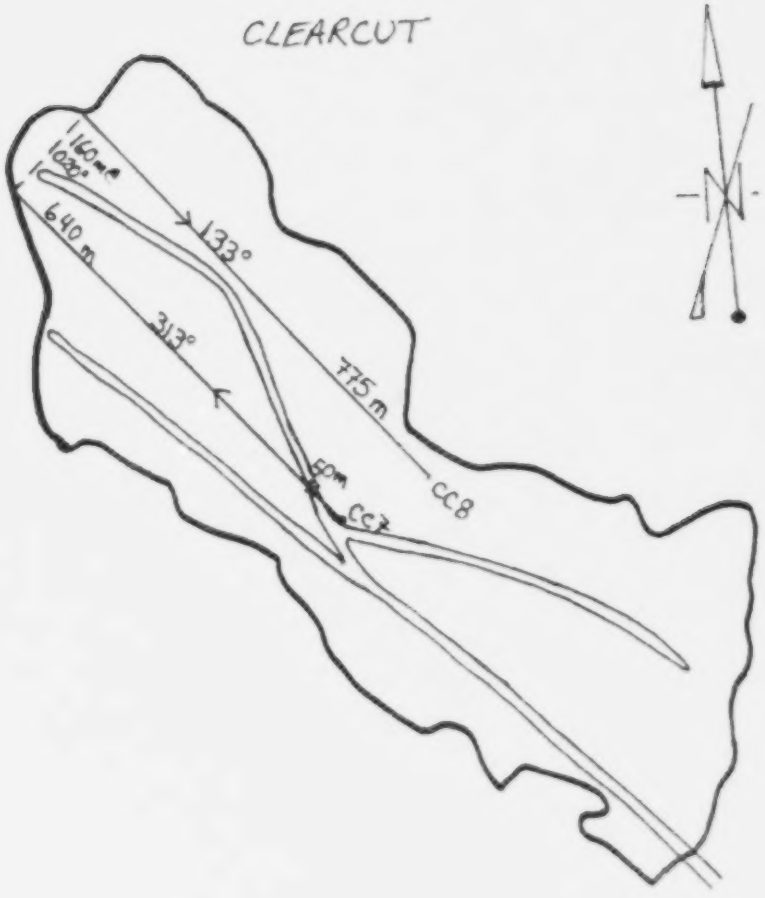

Old Growth 2
OG 2 A
OG 2 B
Tree-Island treatment
Clearcut treatment
Stub & Island treatment
Stub treatment
N
320°
140°
J 930m
K
L
M 585m
N 170m
I 525m
K 1380m
L 1390m
BLOCK 5546


Tree-Island
treatment
Stub & Island
treatment
Stub treatment
Clearcut treatment
Old
Growth 1
BLOCK 5547

BLOCK 5549


CLEARCUT
310°
CC5
150m @
040°/220°
690m
130°
CC4
DONNA CREEK MAINLINE

BLOCK 5550



Appendix B: Sample data forms used to record field observations, and information used to identify mammal tracks.

- Daily record form
- Track transect form
- Track trailing form
- Key to mammal track patterns in the snow
- Comparative characteristics of tracks

DAILY RECORD

Data: Recorder:

Site:

Weather:

Snow Depth (cm): Amt New Snow:

Snow Characteristics:

Temperatures (°C): Maximum: Minimum:

Present: (@ a.m. / p.m.)

Transects/trailing Conducted:

Comments:

DAILY RECORD FORM

Date:

- indicate the date on which the measurements were recorded (day, month and year)

Recorder:

- provide recorder's last name, at a minimum

Site:

- indicate location where measurements are taken and recorded

Weather:

- provide a brief weather synopsis for the day (e.g. clear and sunny in a.m. with cloud cover increasing in p.m. and some snow flurries)

Snow Depth & Amount New Snow:

- provide total snow depth and depth of snow since last snowfall

Snow Characteristics:

- provide comments on general snow conditions (e.g. thin crust below fresh 5cm of snow, or deep powdery snow)

Temperatures:

- provide maximum and minimum temperatures, and note present temperature and time when recording info

Transects/trailing Conducted: (fill in at end of day)

- provide list of all transects and tracks monitored during the day

Comments:

- provide any additional information you feel relevant

TRACK TRANSECT FORM

Observer(s):
- provide observer's last name, at a minimum

Start & Finish:
- indicate the time when the specified transect was commenced and finished (e.g. 0836 or 8:36a.m., 1411 or 2:11p.m.)

Sheet:
- indicate the page number of the individual sheet, and indicate how many pages were used to record info on the identified transect (e.g. 3 of 6)

Transect #:
- indicate the transect letter/number and where the transect was started [e.g. R (start). B (end)]

Date:
- indicate the date that the transect was surveyed (day, month and year)

Last Snowfall & Amount (cm):
- indicate the period of time since the last snowfall, to the nearest 12 hr period, and indicate the amount of snow (cm) that has fallen since the last snowfall

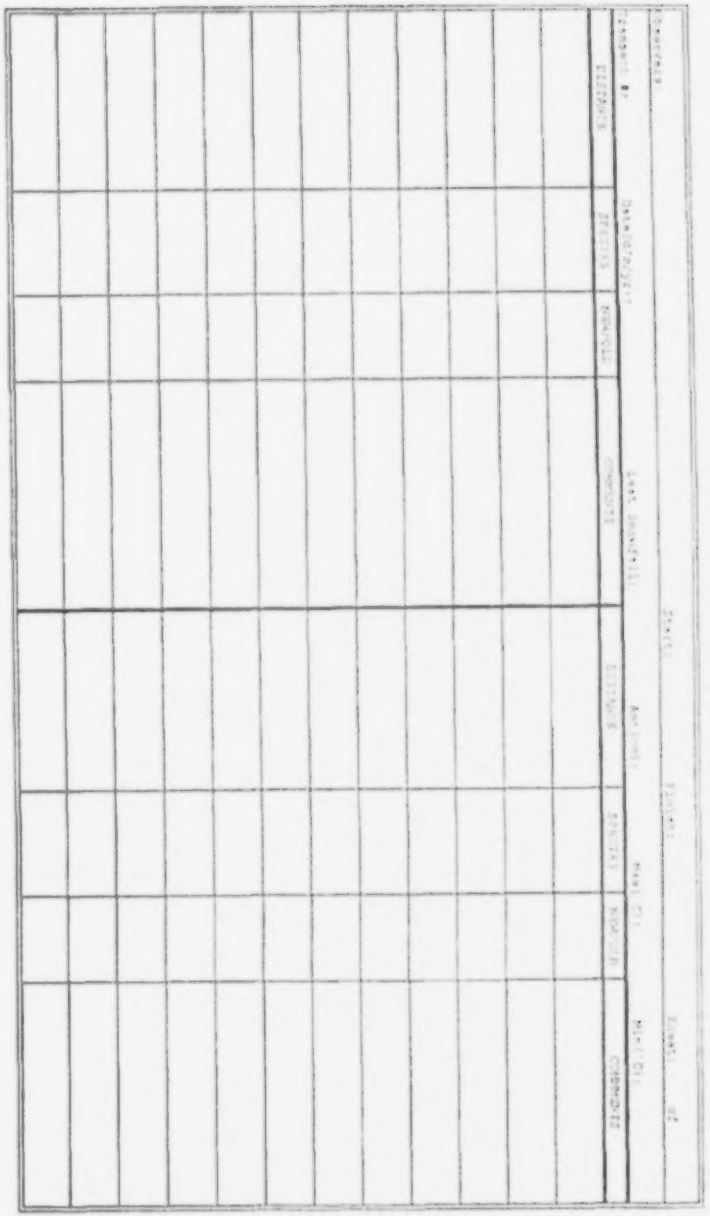
Max. (°C) & Min. (°C):
- indicate the maximum and minimum temperatures (°C)

Distance:
- indicate the distance, in metres (m), at which the track (1) intercepts the transect, or (2) enters the 2m buffer area and does not cross the transect (note in COMMENTS if track only enters buffer without crossing transect)
- if the track follows the transect (within the 2m buffer) denote for what distance this occurs (e.g. from 23-47m)
- only re-count a track if it exits the 2m buffer and (1) re-crosses the transect or (2) re-enters the buffer (make note in COMMENTS)

Species:
- indicate wildlife species that made track - CO (coyote), R (fisher), FX (fox), GR (grouse), LX (lynx), MA (marten), MO (mouse), SH (snowshoe hare), SQ (squirrel), VO (vole), WE (weasel), WOLF (wolf), WOLV (wolverine)

New/old:
- indicate if tracks were laid down before (O - old), during (D) or after (N - new) last snowfall

Comments:
- provide any interesting or additional information observed while traveling the transect i.e. track in buffer only, track size, subnivean access point, scat/ urine, track direction (e.g. towards residual island, along creek), stride pattern (e.g. running, loping), movement pattern (e.g. straight-line, *zigzag*)\



TRACK TRAILING FORM

Observer(s):
- provide observer's last name, at a minimum

Start/Finish Time & Location:
- indicate when (e.g. 0836 or 8:36a.m.) and where trailing of the identified track was commenced/ended (if available, indicate on map)

Sheet:
- indicate the page number of the individual sheet, and indicate how many pages were used to describe the track that was trailed (e.g. 5 of 8)

Track #:
- indicate the track number; use initials of observer and systematic numbering to characterize track number (e.g. FC-1, FC-2, etc.)

Species:
- indicate the wildlife species that made the track being trailed - R (fisher), LX (lynx), MA (marten), WE (weasel), WOLF (wolf), WOLV (wolverine)

Date:
- indicate the date that the track was trailed (day, month and year)

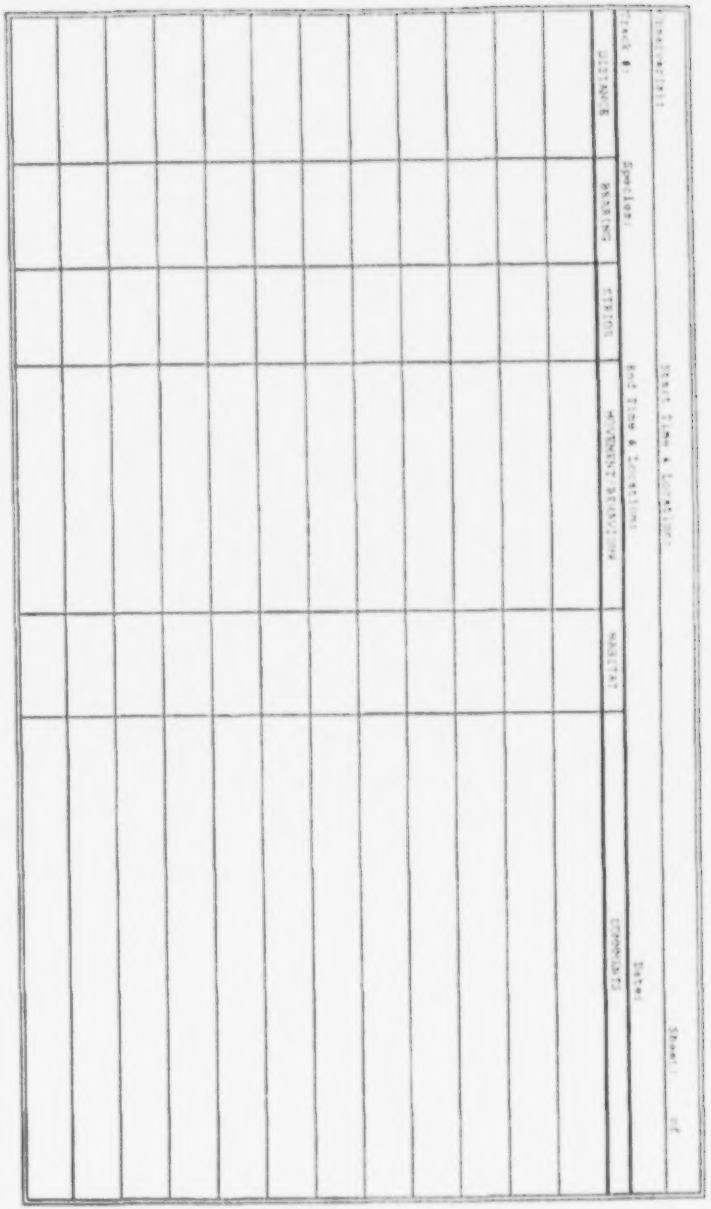
Distance & Bearing:
- indicate the distance, in metres, that the animal traveled in the identified direction (e.g. 143-178m @ 258°)
- if tracks zigzag or meander, provide the bearing for the general direction traveled and indicate in COMMENTS the approx. width of the pattern
- if tracks make a slow arc, provide sufficient distance-bearing combinations to reflect this so maps can be produced
- indicate distances at which important things happen (e.g. subnivean access point, scat/urine), and provide any additional info in COMMENTS

Stride:
- indicate the stride pattern (e.g. 2x - 2x jump, L - 1-2-1x lope, D - dumbbell) and the distance for which it occurs (i.e. 2x from 78-84m)

Movement/Behaviour:
- indicate the movement pattern (e.g. Z - zigzag, M - meandering, S • straight-line) and the distance for which it occurs (i.e. Z from 78-107m); note width of Z or M patterns in COMMENTS

Habitat:
- indicate the habitat or treatment that the tracks pass through (CC - clearcut control, CT - clearcut treatment, I - island treatment, OG - oldgrowth control, RI - residual island, S - stub treatment, SI - stub & island treatment)

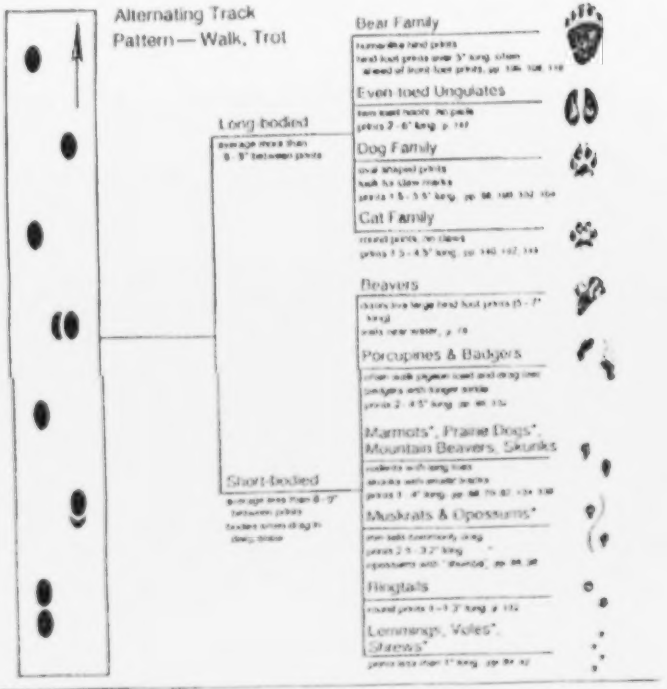
Comments:
- provide any interesting or additional information observed while trailing (i.e. subnivean access point, scat/urine, width of zigzag pattern)



Key taken from *Field Guide To Tracking Animals In Snow*, L. R. Forrest, 1988

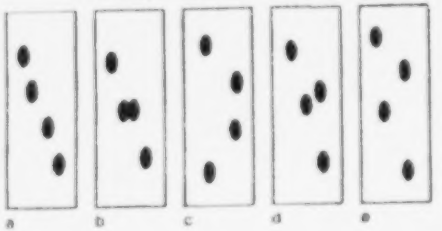
Key to Mammal Track Patterns in Snow

(See Introduction for detailed explanation of track patterns and gaits.)



Less Common Four-print Lope or Gallop Patterns

Prints are generally found in shallow snow



a and b are lopes, c through e are faster gallops
a is common for dogs; b for mustelids; c for dogs, deer, and antelope
e is most common, made by all mammals

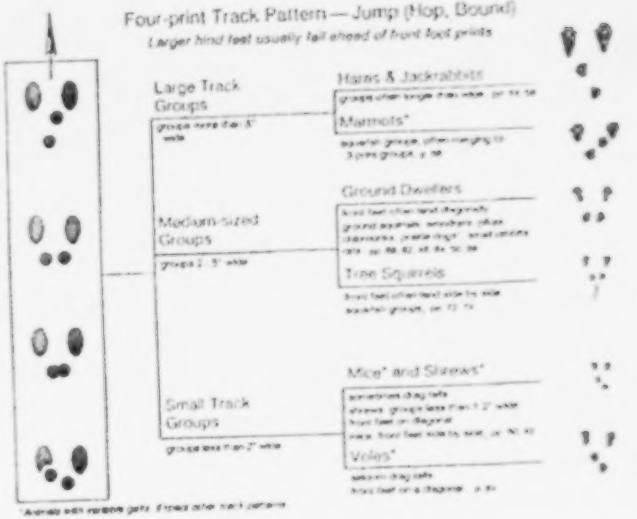
Follow trail for other patterns and clues

When in doubt, follow the trail.

Two-print Track Pattern — Walk, Trot, Bound

Four-print Track Pattern — Jump (Hop, Bound)

Larger hind feet usually fall ahead of front foot prints



*Animals with variable gaits. Prints other than patterns

	Weasel Family				Dog Family			Cat Family
	Wolverine	Fisher	Marten	Weasel	Wolf	Coyote	Red Fox	Lynx
Track Formula	f5(4)H5(4)	f5(4)H5(4)	f5(4)H5(4)	f5(4)H5(4)	F4h4	F4h4	F4h4	F4h4
Print Features								
- size (l x w; cm)	10x10	6x6	4x4	1x1	12x11	7x6	6x5	10x10
- largest foot	hind	hind	hind	hind	front	front	front	front
- largest toe	outer	outer	outer	outer				
- plantar pad	asym. chev	asym. chev	asym. chev	asym. chev	single lobe	single lobe	sym. chev	bi-lobed
- claw presence	common	occasional	occasional	occasional	common	common	common	rare
- comments	1-3-(1)	1-3-(1)	1-3-(1)	1-3-(1)	2-2	2-2	2-2, spaces betw pads	tracks obscured
Gait Features								
- most common	1-2-1, 2x	2x, walk	2x, 1-2-1	2x	alternating	alternating	alternating	alternating
- stride (walk)	65	50	30		100	75	65	65
- straddle (walk)	20	15	9		18	12	10	18
- group (2x)		30	20					
- intergroup (2x)		50	30					
- comment	foot drag	poss. body & foot drag		dumbbell, zigzag*	foot drag	foot drag	prints in a line	foot rarely drags

NOTE: measurements presented in centimetres (cm)

RODENT/HARE CHARACTERISTICS

Porcupine: f4H5; pigeon-toed waddle; quill marks; seldom do all toes show; troughs common.

Snowshoe hare: f4(5)H4; 4x hop; front prints on a diagonal; prints indistinct; symmetric chevron plantar pad; evenly spaced toe pads; no heel prints when walking.

Squirrel: f4H5; 4x hop; front prints side-by-side; feet and tail drag; tracks usu. end at base of tree.

Chipmunk: f4H5; 4x hop; front prints on a diagonal; tracks seldom end at base of tree.

Mice: f4H5; 4x hop; front prints side-by-side; tail drag common.

Voles/lemmings: f4H5; 4x hop and walk; front prints on a diagonal; tail drag uncommon.

Shrew: f4H5; 4x hop that looks U-shaped; tail drag common.

GAIT PATTERNS

TERMS:

Stride - one complete cycle of locomotion; distance from where a foot touches the ground to where the same foot touches next

Straddle - distance between outside of left foot to outside of right foot for the same pair (front or hind).

Group - all foot prints within a stride; distance from back of posterior-most pad to front of anterior-most pad.

Intergroup - distance between groups; distance from front of anterior-most pad to back of posterior-most pad of the next group).

TYPES:

Walking - tracks gen. in a line; usu. direct registry; pattern maintained for long distances; placement of hind feet varies with speed.

Trotting - paired movements of diagonal limbs (e.g. RF & LH); stride longer and straddle narrower than for a walk; maintained for long distances; placement of hind foot varies with speed; "side-trot" when body turned at slight angle to direction of travel.

Galloping - one period during stride when all feet off the ground; usu. disting group and intergroup; variable patterns due to change in lead foot (front . hind) and speed; rotary or C-shaped (common for canids); transverse or Z-shaped; 1-2-1 lope (common for mustelids); one gallop pattern not maintained for long distances.

Bounding - one period during stride when all feet off the ground; different from a gallop by hind feet placed side-by-side

Compiled from *A Field Guide to Mammal Tracking In North America*, J. Halfpenny, 1986

Appendix C: Track transect survey data for January and March 1994.

January/94

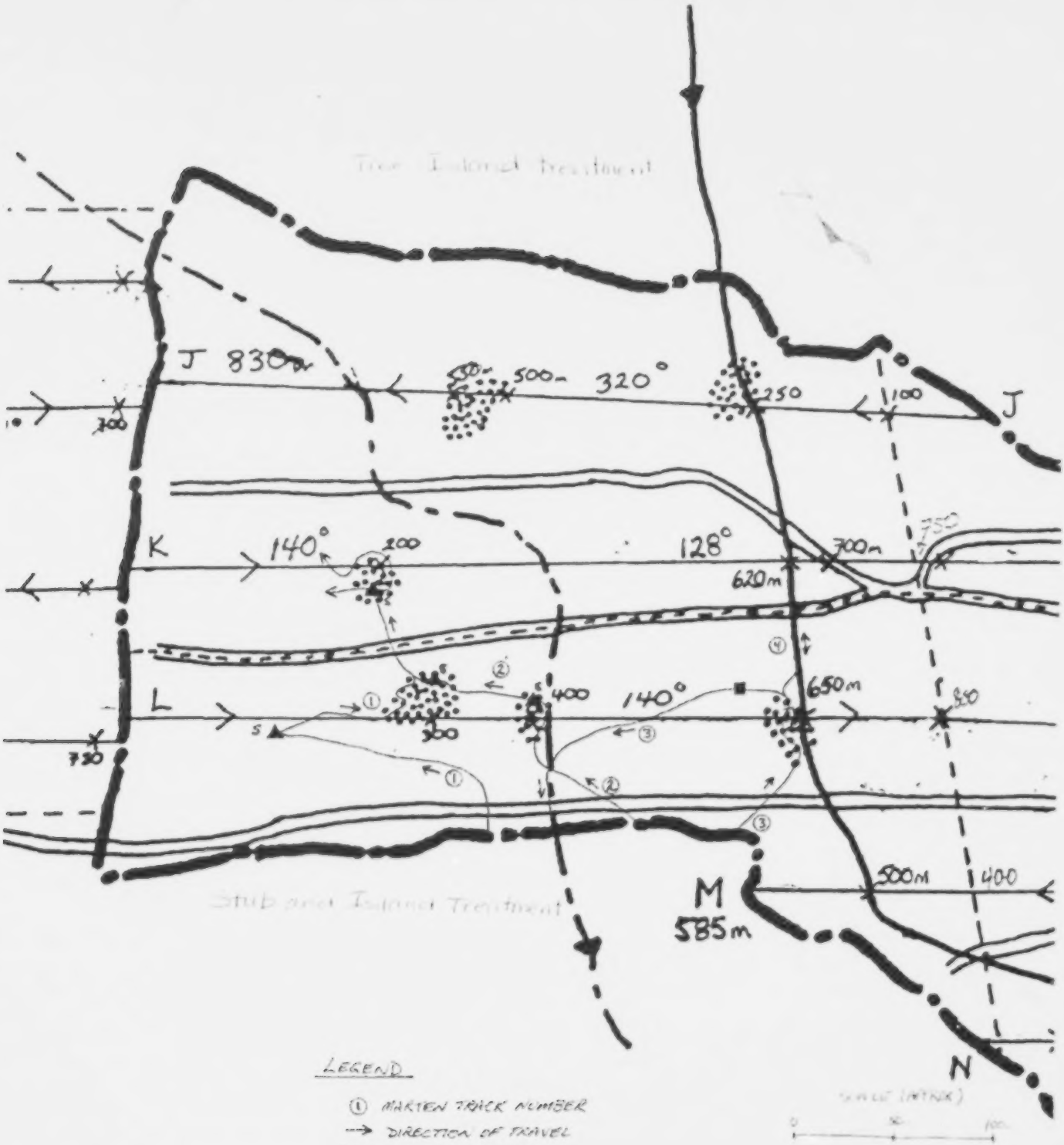
Block	Strip	Trtmt	Dist (m)	Days	SPECIES									
					MA	WE	SH	SQ	WO	LX	FX	CO	GR	VO/MO
5547	A	TI	900	1	6	2								
		SI	337	1	4									
	B	SI	426	1										
		TI	593	1	1	8								
	C	TI	660	1										
		SI	317	1										
	D	SB	480	1										
		CT	370	1										
	E	CT	150	2	1									
		SB	520	2	8									
	F	SB	600	2	4									
		CT	305	2										
	G	CT	200	2										
		SB	530	2										
	H	SB	600	2										
		CT	130	2										
	1a	OG	350	1	1			8						
	1b	OG	275	1	1									
	1c	OG	450	1	1			1						
	1d	OG	350	2	3									
	Subtotal		9,132		31	10	0	9	0	0	0	0	0	0
5546	I	CT	525	3										
	J	CT	100	3										
		TI	730	3	2									
	K	TI	760	3	6									
		CT	630	3										
	L	SI	900	2	2								1	
		SB	590	2			2							
	M	SB	400	2		1								
		SI	185	2			2							
	N	SB	170	2										
	2A top	OG	350	3	1			4						
	bottom	OG	350	3	2		1							
	2B	OG	300	2	3		2							
	2Bb	OG	300	2	6	1	6							
	Subtotal		8,180		21	2	13	4	0	0	0	0	1	0
5518	R	SI	400	3		6								
		TI	300	3		1								
		CT	580	3		7								
	S	CT	400	3		15								
		TI	300	3		7								
		SI	450	3		3								
	T	SI	500	3		9								
		TI	300	3		1								
		CT	280	3		3								
	U*	CT	0											
	*	TI	180	3		2								
	*	SB	280	3		2								
	V	SB	550	3		7								
		TI	360	3		2								
		CT	100	3										
	W	TI	325	3										
		SB	515	3		8								
	3a	OG	750	4	3	5	8	12						1
	3b	OG	750	4			33	26		1				
	Subtotal		7,280		3	75	41	37	0	1	0	0	0	1
GRAND TOTAL			21,592		55	87	54	50	0	1	0	0	1	1

* Transect "U" is actually 1,040m long [0-150m(CT), 150-480m(TI), and 480-1,040m(SB)], but only parts of the transect were completed on this survey due to avalanche risk.

March/94

Block	Strip	Treat	Dist (m)	Days	SPECIES									
					MA	WE	SH	SO	WO	LX	FX	CO	GR	VO.MO
6547	A	TI	600	4					3					
		SI	337	4										
	B	SI	425	4										
		TI	583	4					3		1			
	C	TI	650	4					3					2
		SI	317	4										
	D	SB	490	4		12			3					
		CT	370	4										
	E	CT	150	4										
		SB	520	4		2			3					
	F	SB	500	4		4								
		CT	305	4		1								
	G	CT	200	4										
		SB	530	4										
	M	SB	500	4					3					
		CT	130	4										
	1a	OG	380	4	3		2	28						
	1b	OG	376	4			2	11						
	1c	OG	480	4	1	6		8						
	1d	OG	380	4		3		6		1				
	Subtotal		8,132		4	27	4	60	18	1	1	0	0	2
6548	I	CT	525	4										
	J	CT	100	4										
		TI	730	4										
	K	TI	760	4										
		CT	630	4										
	L	SI	800	4										
		SB	590	4						1		1		
	M	SB	400	4								2		
		SI	195	4										
	N	SB	170	4								1		
	2A-top	OG	360	4	1		3	12						
	bottom	OG	350	4			9	7						
	2B	OG	300	4		1	3	6						
	2Bb	OG	300	4	1			12						
	Subtotal		6,180		2	1	15	37	0	1	0	4	0	0
GRAND TOTAL			14,312		6	28	19	97	18	2	1	4	0	2

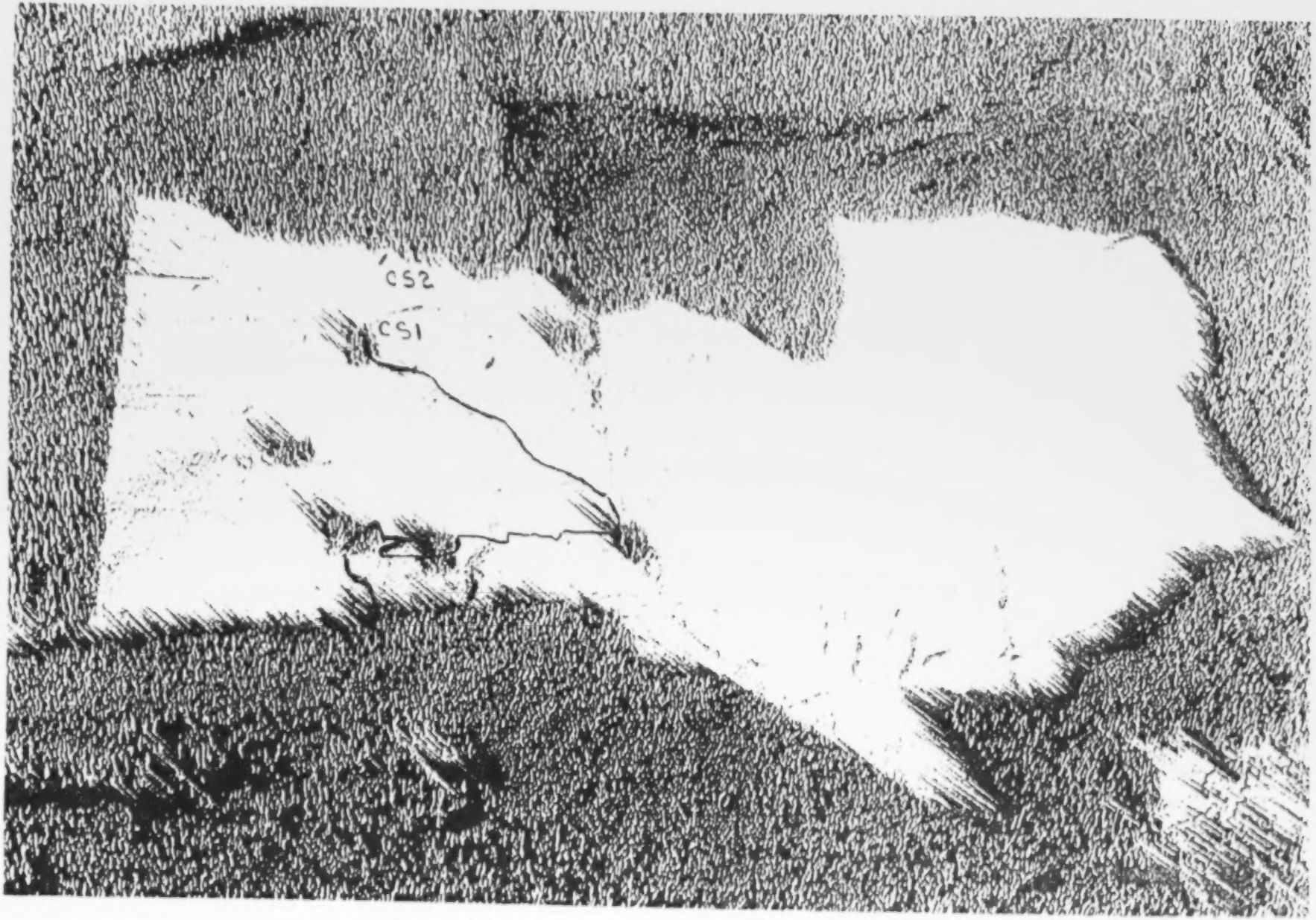
Appendix D: Map of trailed marten tracks in SI treatment of Cutblock 5546, 20 January 1994.


J 830m
500m
320°
250
100
J
300
K
140°
200
128°
700m
620m
750
L
140°
400
650m
300
730
M
585m
500m
400
N
LEGEND
① MARTEN TRACK NUMBER
DIRECTION OF TRAVEL
S SUBNIVEAN ACCESS
URINE SCENT MARK
TREATMENT BOUNDARY

BLOCK 5546

Appendix E: Maps of trailed marten and fisher tracks in January and February 1996.

Treatment cutblocks - 5 track trails
OG control areas - 26 track trails



Jan. 25 1996

BLOCK 5546

0 8 16 KM

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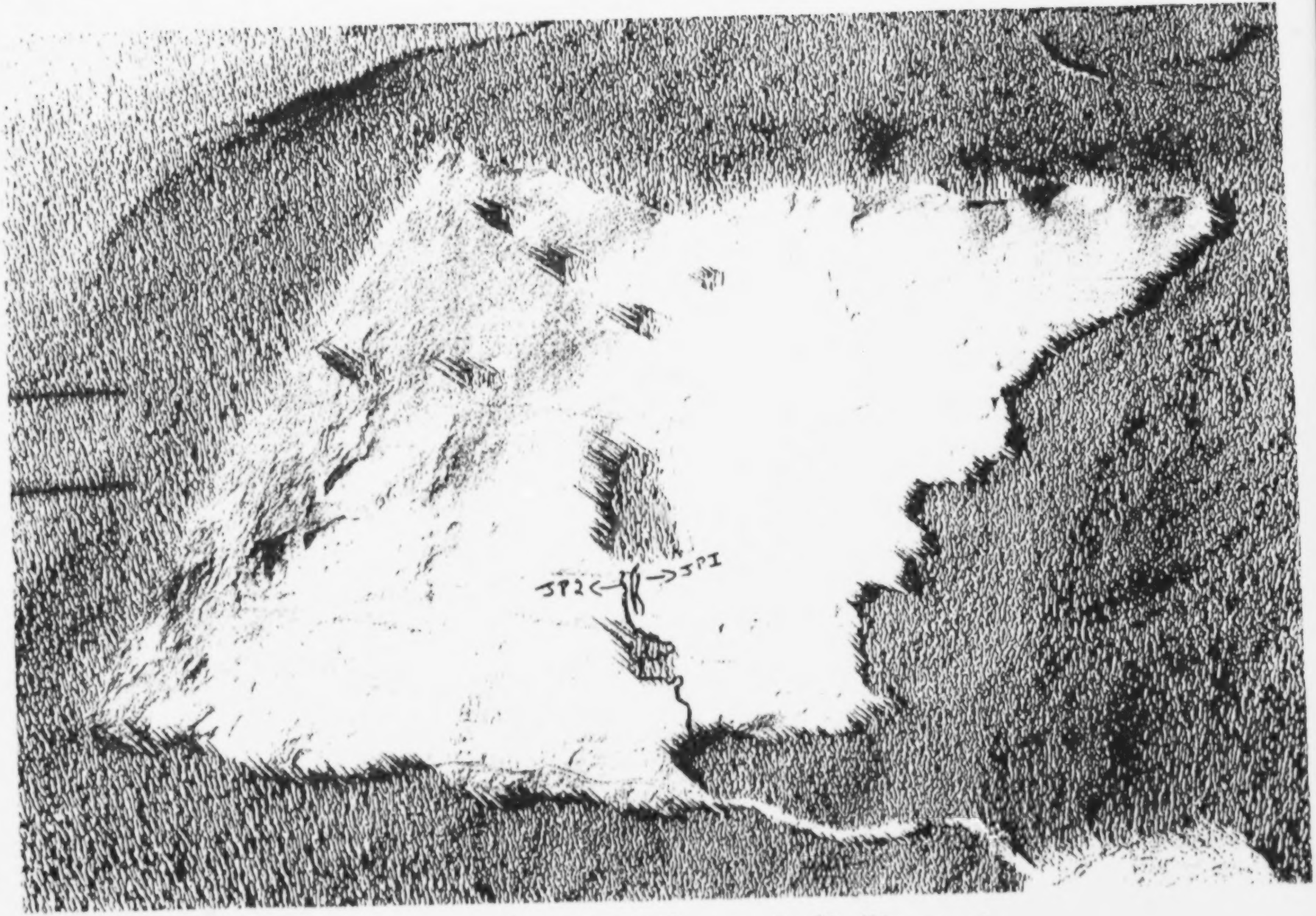
COMPUTATION SHEET

Project _____ Sheet ____ of ____

Computation of _____

Computed by _____ Date _____



Jan 25 1996 BLOCK 5516 0 8 16 miles (approx.)

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COMPUTATION SHEET

Project _____ Sheet ____ of ____

Computation of _____

Computed by _____ Date _____

A to B

Total dist	67m
Direct dist	67m
Ratio	1.00

B to C

Total dist	76m
Direct dist	71m
Ratio	1.01

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COMPUTATION SHEET

Project _____ Sheet ____ of ____

Computation of _____

Computed by _____ Date _____

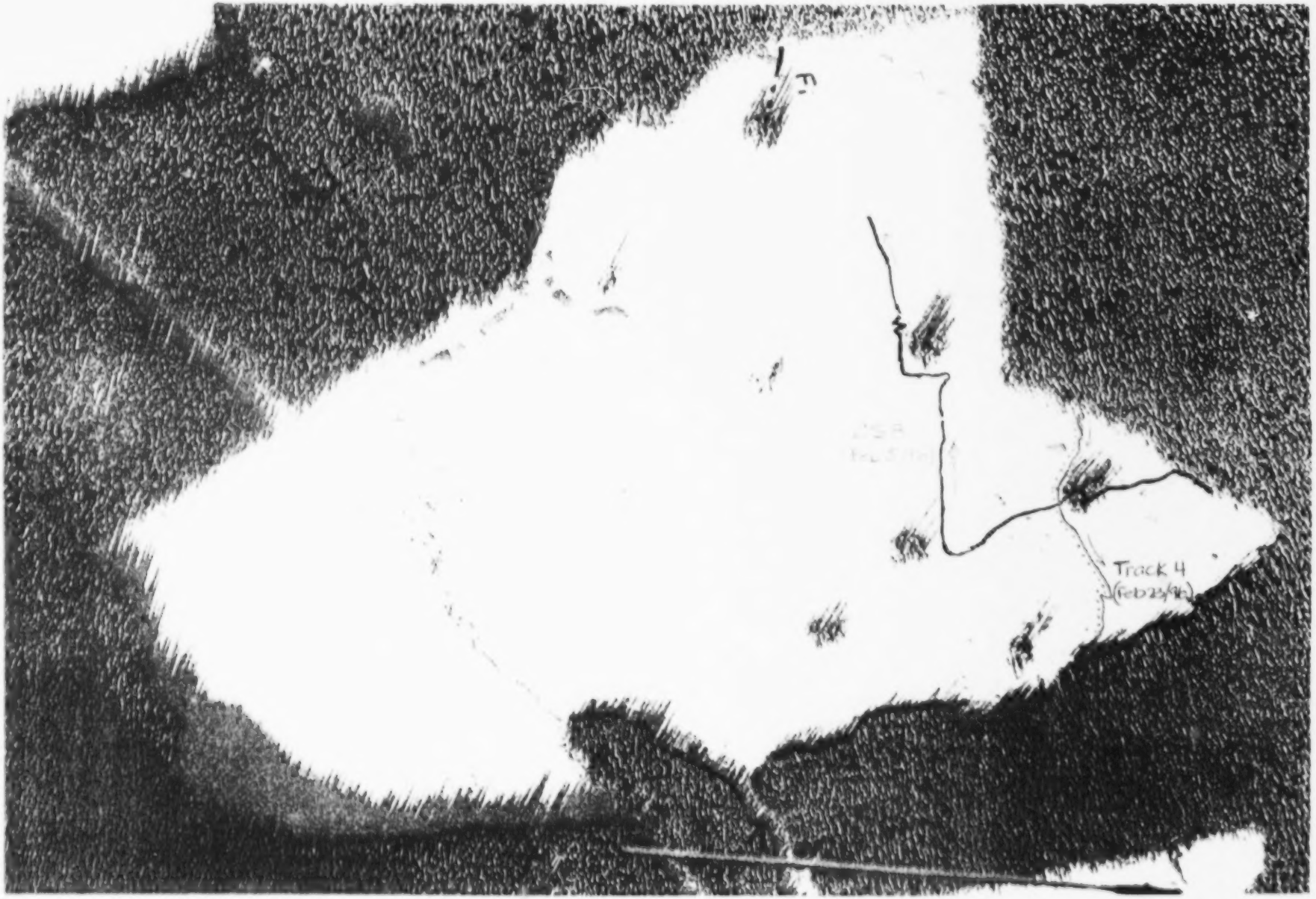
FORM 1003(11-71)

COMPUTATION SHEET

Project _____ Sheet ____ of ____

Computation of _____

Computed by _____ Date _____



BLOCK 5547

0 8 16 km (approx)

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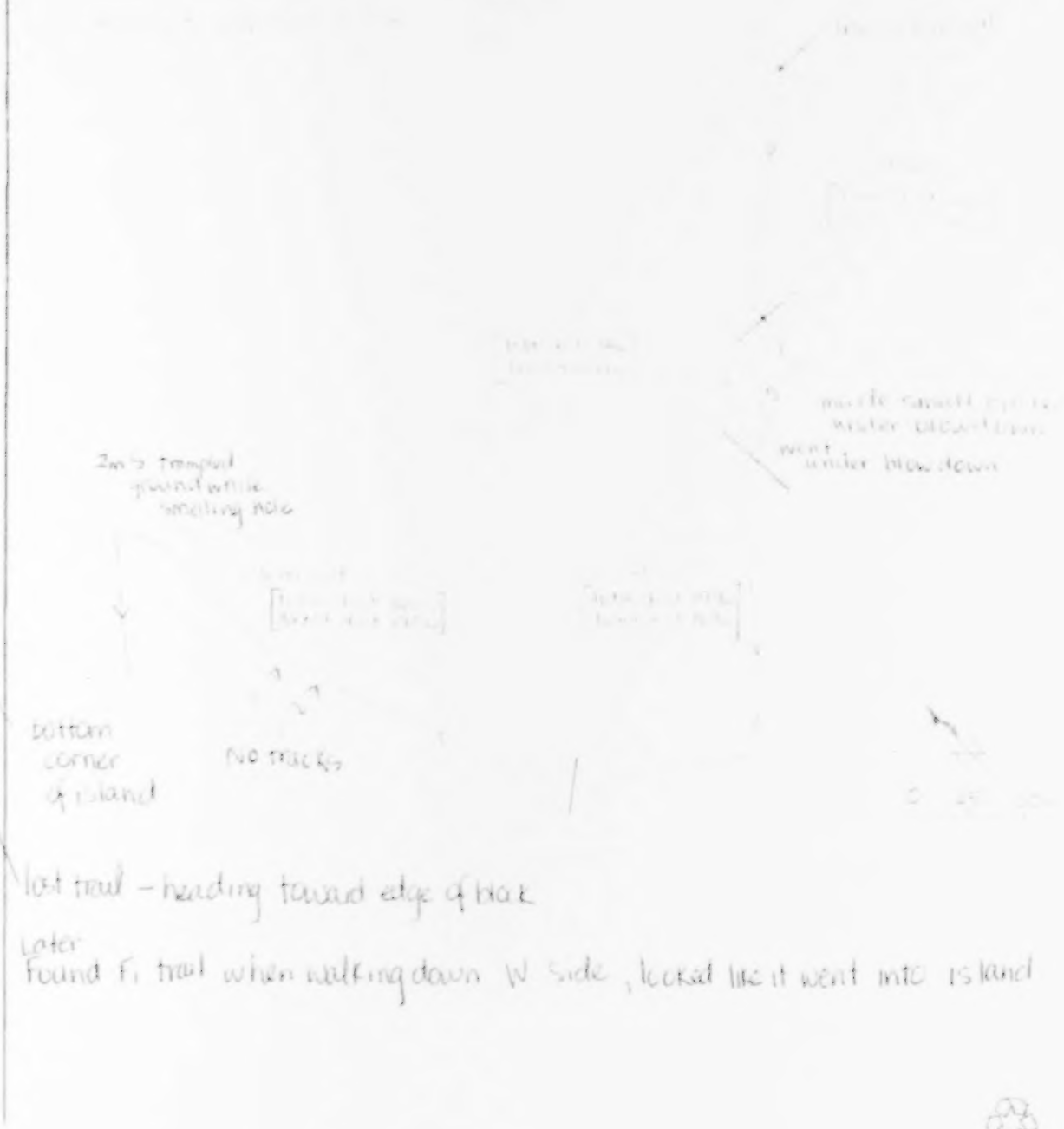
COMPUTATION SHEET

Project _____ Sheet ____ of ____

Computation of _____

Computed by _____ Date _____


2m² trampled ground with smelling hole
bottom corner of island
NO TRACKS
last trail - heading toward edge of bluff
Later found Fi trail when walking down W side, looked like it went into island

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COMPUTATION SHEET

Project _____ Sheet ____ of ____

Computation of _____

Computed by _____ Date _____

FORM 1093(11-71)

COMPUTATION SHEET

Project _____ Sheet ____ of ____

Computation of _____

Computed by _____ Date _____

FORM 1003111-211

COMPUTATION SHEET

Project _____ Sheet _____ of _____

Computation of _____

Computed by _____ Date _____

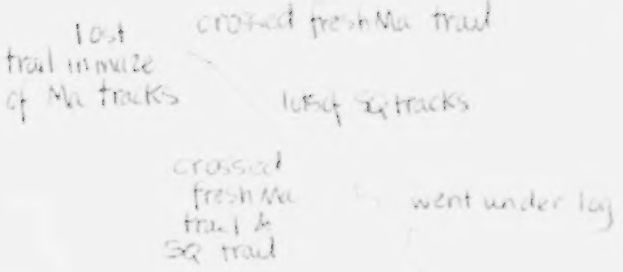
FORM 10831(11-71)

COMPUTATION SHEET

Project _____ Sheet ____ of ____

Computation of _____

Computed by _____ Date _____



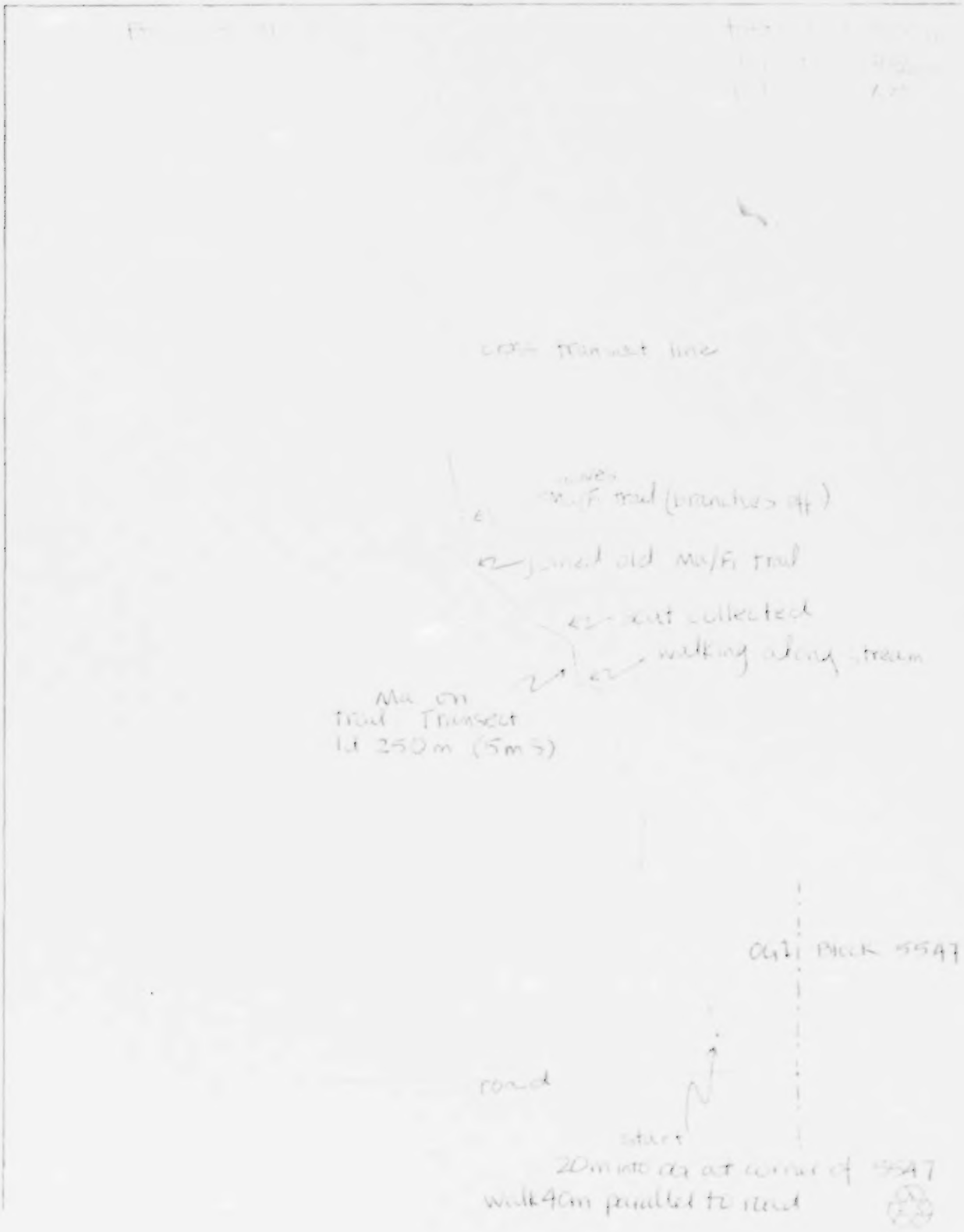
FORM 1993111-11

COMPUTATION SHEET

Project _____ Sheet ____ of ____

Computation of _____

Computed by _____ Date _____



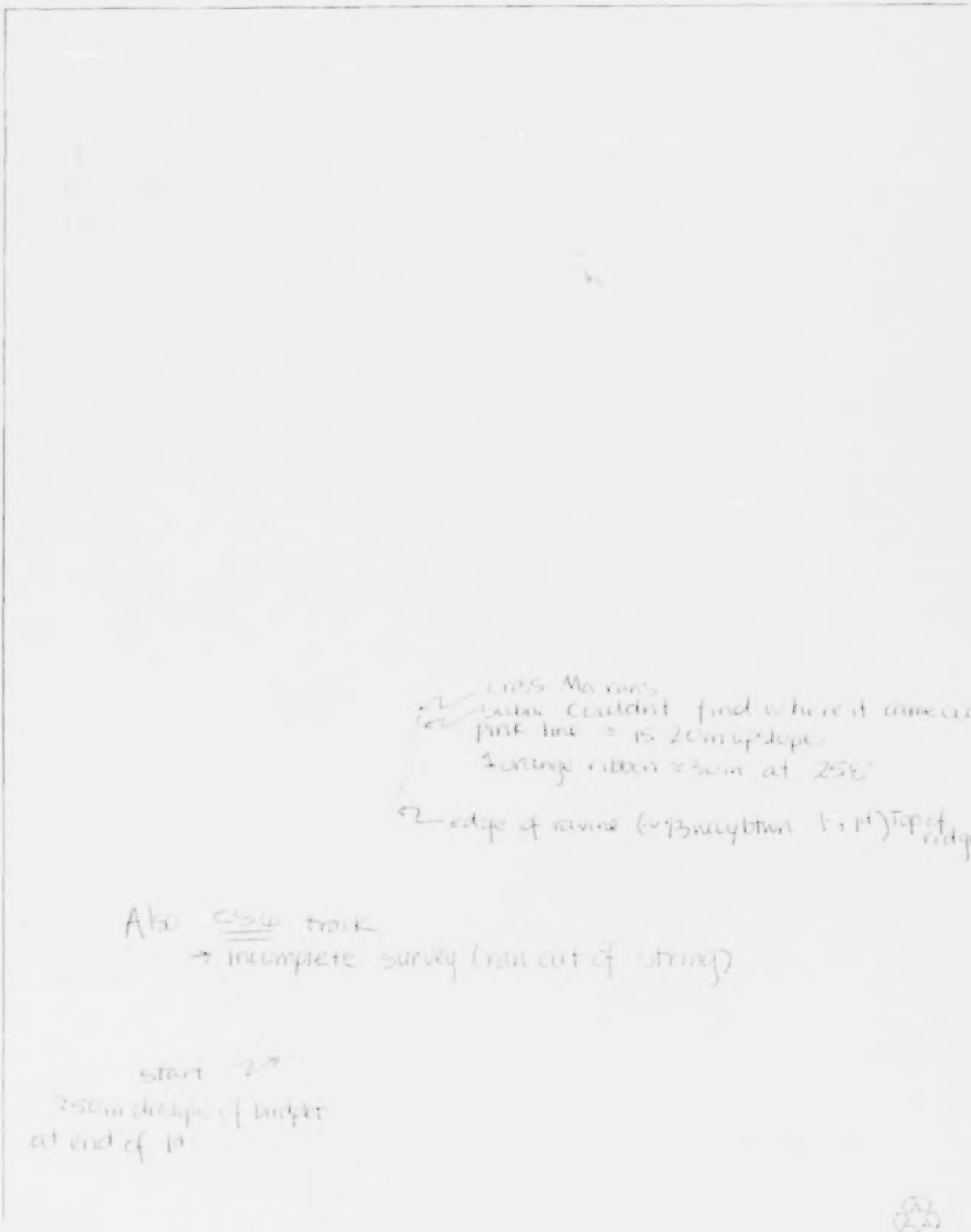
FORM 1083111-71

COMPUTATION SHEET

Project _____ Sheet ____ of ____

Computation of _____

Computed by _____ Date _____


LIDS Markers
Saltan Coulant find where it came out
Pink line = 15.2cm up slope
Orange ribbon = 30cm at 25E
E2 edge of ravine (+/- 3m) bottom 1.5m Top of ridge
Also E5 track
→ incomplete survey (ran out of string)
start
3.50m change of budget
at end of 10

FORM 10931-11 7/71

COMPUTATION SHEET

Project _____ Sheet ____ of ____

Computation of _____

Computed by _____ Date _____

start

Zup rope from fully ext carrier

submerged & emerged from same hole

lost trail either went up tree or submerged

C56

total dist 15ft

DIRECT 20m

RATIO .745

OG 2

~ 64 km (approx.)

FORM 10931111-711

COMPUTATION SHEET

Project _____ Sheet ____ of ____

Computation of _____

Computed by _____ Date _____

line 2A (320/140°)

start 41.9m from bottom edge of CG2
(block 5546 side) submerian site
116.6m from line A in CG2A

crossed Ma, Sh, Ma tracks

crossed Ma tracks

10ft of Sh tracks

crossed line 2B by tree #251

followed Sh run

See map

came to tree
LCSI found in 5 different tracks

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Computation of _____

Computed by _____ Date _____

See map

FORM 1993(11-71)

COMPUTATION SHEET

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Computation of _____

Computed by _____ Date _____

Started
25 m from
North end of
OG

FORM 10631-11-71

COMPUTATION SHEET

Project _____ Sheet ____ of ____

Computation of _____

Computed by _____ Date _____

FORM 10931(11-71)

COMPUTATION SHEET

Project _____ Sheet ____ of ____

Computation of _____

Computed by _____ Date _____

FORM 1093111-111

COMPUTATION SHEET

Project _____ Sheet ____ of ____

Computation of _____

Computed by _____ Date _____

FORM 10031 (3-71)

COMPUTATION SHEET

Project _____ Sheet ____ of ____

Computation of _____

Computed by _____ Date _____

Start Line 1d

Encountered tree & jumped down

Sniffed around tree limbs

(jumped from tree see tadpoint not last tracks)

FORM 1003-11-71

COMPUTATION SHEET

Project _____ Sheet ____ of ____

Computation of _____

Computed by _____ Date _____

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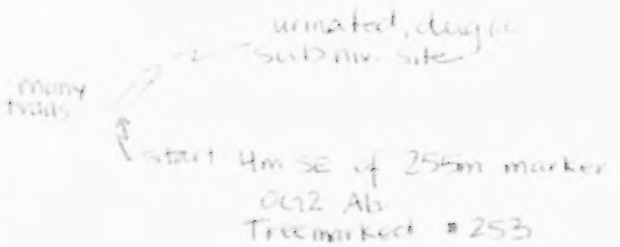
COMPUTATION SHEET

Project _____ Sheet ____ of ____

Computation of _____

Computed by _____ Date _____

One of an Ma pair?



either same as CS11 or 'partner' of CS11

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COMPUTATION SHEET

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Computation of _____

Computed by _____ Date _____

meets another Ma trail just above
CS 10 area where trail 10a
≈ 30m NW of tree 254

either same as, or part of, CS 10

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COMPUTATION SHEET

Project _____ Sheet ____ of ____

Computation of _____

Computed by _____ Date _____

FORM 10931 11-71

COMPUTATION SHEET

Project _____ Sheet ____ of ____

Computation of _____

Computed by _____ Date _____

COMPUTATION SHEET

Project _____ Sheet ____ of ____

Computation of _____

Computed by _____ Date _____

start time of 3A+4C

end location at rec

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Computation of _____

Computed by _____ Date _____

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Computation of _____

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COMPUTATION SHEET

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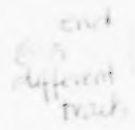
Computation of _____

Computed by _____ Date _____



FORM 1093(11-71)

COMPUTATION SHEET

Project _____ Sheet ____ of ____

Computation of _____

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FORM 1093111-71

COMPUTATION SHEET

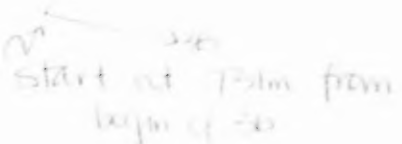
Project _____ Sheet ____ of ____

Computation of _____ 2nd

Computed by _____ Date _____ (look like

modified

there)



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COMPUTATION SHEET

Project _____ Sheet ____ of ____

Computation of _____

Computed by _____ Date _____

FORM 1993-11-111

COMPUTATION SHEET

Project _____ Sheet ____ of ____

Computation of _____

Computed by _____ Date _____

Appendix F: Calculated linearity indices for marten and fisher trails in tree-island, non-treed, and old-growth habitat types, 25 January to 27 February, 1996.

Non-treed	Tree-island	Old-growth
1.30	2.78	1.25
1.07	1.07	1.19
1.07	1.19	1.10
1.34	1.21	2.03
1.28		1.76
1.17		1.47
1.00		1.30
1.01		1.74
		6.53
		7.95
		1.01
		1.22
		1.14
		1.85
		1.74
		1.08
		3.05
		2.00
		1.03
		1.08
		1.43
		1.33
		4.00
		1.04
		1.57
		0.93
8	4	26